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Final (2nd Revision)

Phase II RCRA Facility Investigation Report

Tooele Army Depot-North Area
Group A Suspected Releases SWMUs

Volume I
Text

August 1997

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MONTGOMERY WATSON

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U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MD

FINAL (2ND REVISION)
RCRA FACILITY INVESTIGATION REPORT
TOOELE ARMY DEPOT NORTH AREA
GROUP A SUSPECTED RELEASES SWMUs
PHASE II STUDY

August 1997

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13. ABSTRACT (Maximum 200 words)

Environmental investigations were conducted during 1993-1995 at eleven solid waste management units (SWMUs) or sub-SWMUs at the Tooele Army Depot-North Area (TEAD-N) as part of a Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) under the terms of a State of Utah Corrective Action Permit. Environmental sampling and an ecological survey were conducted at each SWMU to determine the horizontal and vertical extent of waste constituents found to be present during a previous Phase I RFI at TEAD-N. The generated data were used to perform risk assessments for each of the investigated SWMUs.

A total of 299 soil samples, two sediment samples, seven water samples, and two total suspended particulate (air filter) samples were collected during the Phase II sampling, as well as 19 background soil samples. Based on the Phase I and Phase II sampling results, and the subsequent risk assessments, two SWMUs are recommended for no further action under the current Corrective Action Permit and nine SWMUs or sub-SWMUs are recommended for RCRA Corrective Measures Studies (CMS) based on possible risks to on-site workers or the environment.

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ACRONYMS

AED	Ammunition Engineering Directorate
AEHA	(U.S.) Army Environmental Hygiene Agency
ARAR	Applicable or Relevant and Appropriate Requirement
ASCS	Agricultural Stabilization and Conservation Service
AST	Aboveground Storage Tank
ASTM	American Society for Testing and Measures
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
bgs	below ground surface
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
BTXE	Benzene, Toluene, Xylene, Ethylbenzene
CDM	Camp, Dresser, and McKee
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cm/s	centimeters per second
CMS	Corrective Measures Study
COC	Chain of Custody
COD	Criteria of Detection
COEC	Contaminant of Ecological Concern
COPC	Chemicals of Potential Concern
COPEC	Chemicals of Potential Ecological Concern
CRL	Certified Reporting Limit
CRS	Caldwell Richards and Sorensen Engineering Inc.
CTE	Central Tendency Evaluation
CWP	Contaminated Waste Processing Plant
DCQAP	Data Collection Quality Assurance Plan
DMP	Data Management Plan
DQO	Data Quality Objective
DRMO	Defense Reutilization and Marketing Office
DTSC	(California) Department of Toxic Substances Control
DUP	Duplicate
EA	Environmental Assessment
ED	Exposure Dose
EMO	Environmental Management Office
EOD	Explosive Ordnance Disposal
EP Toxicity	Extraction Procedure Toxicity
EPIC	Environmental Photographic Interpretation Center
ERC	Enviro-Recovery Consultants
ERTEC	Earth Technology Corporation
ESE	Environmental Science and Engineering
ETQ	Ecological Toxicity Quotient
FFA	Federal Facility Agreement
FS	Feasibility Study
ft/ft	feet per foot
ft/yr	feet per year

g/cc	Grams Per Cubic Centimeter
GAC	Granular Activated Carbon
GC/MS	Gas Chromatography
GFAA	Graphite Furnace Atomic Absorption
GMA	Geotechnical Map File
gpd/ft^2	gallons per day per square foot
HASP	Health and Safety Plan
HDPE	High-density Polyethylene
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HPLC	High Performance Liquid Chromatography
HSWA	Hazardous and Solid Waste Amendments
HWCP	Hazardous Waste Contingency Plan
ICP	Inductively Coupled Plasma Atomic Absorption
IDW	Investigation-Derived Wastes
IRA	Interim Remedial Action
IRDMIS	Installation Resotration Data Management System
IRIS	Integrated Risk Information System
IWL	Industrial Wastewater Lagoon
IWTP	Industrial Wastewater Treatment Plant
JMM	James M. Montgomery, Consulting Engineers, Inc.
Jordan	E.C. Jordon Company
LCS	Laboratory Control Samples
LDI	Lifetime Daily Intake
LOAEL	Lowest Observed Adverse Effect Level
mg/kg	milligram per kilogram
mg/m^3	milligram per cubic meter
MCL	Maximum Contaminant Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSL	Mean Sea Level
MW	Montgomery Watson
NAWC	North American Weater Consultants
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NOAEL	No Observed Adverse Effect Level
NTU	Nephelometric Unit
OB/OD	Open Burning/Open Detonation
OCP	Organochlorine Pesticides
OSO	On-site Safety Officer
PA/SI	Preliminary Assessment/Site Investigation
PAH	Polycyclic Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PCDD	Polychlorinated Dibenzo Dioxin
PCDF	Polychlorinated Dibenzo Furan
PEF	Potency Equivalency Factor
PID	Photoionization Detector
PMP	Project Management Plan
ppb	parts per billion

PPE	Personal Protective Equipment
PQL	Practical Quantitation Limits
PRI	Potomac Research Institute
PRG	Preliminary Remedial Goals
PVC	Polyvinyl Chloride
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RPD	Relative Percent Difference
SF	Slope Factor
SPCCP	Spill Prevention Control and Countermeasures Plan
SVOC	Semi-volatile Organic Compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCLP	Toxic Characteristics Leaching Procedure
TEAD-N	Tooele Army Depot, North Area
TEAD-S	Tooele Army Depot, South Area
TEF	Toxicity Equivalency Factors
TIC	Tentatively Identified Compound
TNT	Trinitrotolune
TPH-D	Total Petroleum Hydrocarbon as Diesel
TPH-G	Total Petroleum Hydrocarbon as Gasoline
TRPH	Total Recoverable Petroleum Hydrocarbons
TSP	Total Suspended Particulates
UAC	Utah Administrative Code
UCL	Upper Confidence Limit
UDEQ	Utah Department of Environmental Quality
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
EPA	(U.S.) Environmental Protection Agency
USGS	U.S. Geological Survey
USSCS	U.S. Soil Conservation Service
UST	Underground Storage Tank
UTL	Upper Tolerance Limit
UXB	UXB International Inc.
UXO	Unexploded Ordnance
GC	Gas Chromatography
VOC	Volatile Organic Compound
WCC	Woodward-Clyde Consultants
XRF	X-ray fluorescence
μg/g	microgram per gram
μg/L	micrograms per liter

IRDMIS CHEMICAL ACRONYMS

124TCB	1,2,4-Trichlorobenzene
135TNB	1,3,5-Trinitrobenzene
13DNB	1,3-Dinitrobenzene
2,3,7,8-TCDF	2,3,7,8-Tetrachlorodibenzofuran
24DCLP	2,4-Dichlorophenol
24D	2,4-Dichlorophenoxyacetic acid
24DNT	2,4-Dinitrotoluene
246TNT	2,4,6-Trinitrotoluene
26DNT	2,6-Dinitrotoluene
2E1HXL	2-Ethyl-1-hexanol
2MENAP	2-(1-Methylethyl)naphthalene
4MP	4-Methylphenol
ACET	Acetone
ACLDAN	alpha-Chlordane
AG	Silver
ANAPNE	Acenaphthene
ANTRC	Anthracene
AS	Arsenic
B2EHP	bis(2-Ethylhexyl)phthalate
BA	Barium
BAANTR	Benzo(a)anthracene
BAPYR	Benzo(a)pyrene
BBFANT	Benzo(b)fluoranthene
BBZP	Butylbenzylphthalate
BE	Beryllium
BGHIPY	Benzo(ghi)perylene
BKFANT	Benzo(k)fluoranthene
C1O	Decane
C21	Heneicosane
CA	Calcium
CCL3F	Trichlorofluoromethane
CD	Cadmium
CH2CL2	Methylene Chloride
CHCL3	Chloroform
CHRY	Chrysene
CL	Chloride
CL6BZ	Hexachlorobenzene
CR	Chromium
CR(VI)	Hexavalent Chromium
CR(III)	Trivalent Chromium
CU	Copper
CYN	Cyanide
DLDRN	Dieldrin
DMP	Dimethylphthalate
DNBP	Di-n-butylphthalate

ENDRN	Endrin
ETC6H5	Ethylbenzene
FANT	Fluoranthene
FE	Iron
FLRENE	Fluorene
FURANS	Dibenzofurans - nonspecific
GCLDAN	gamma-Chlordane
HEXANE	Hexane
HG	Mercury
HMX	Cyclotetramethylenetetranitramine
HPCDD	Hepta-dioxins
HPCDF	Hepta-furans
HPCL	Heptachlor
HXCDD	Hexa-dioxins
HXCDF	Hexa-furans
ICDPYR	Indeno(1,2,3-cd)pyrene
ISODR	Isodrin
K	Potassium
MEC6H5	Toluene
MESTOX	Mesityl oxide/4-Methyl-3-penten-2-one
MG	Magnesium
MN	Manganese
NA	Sodium
NAP	Naphthalene
NB	Nitrobenzene
NG	Nitroglycerine
NI	Nickel
NIT	Nitrite, nitrate - nonspecific
NNDPA	N-Nitrosodiphenylamine
OCDD	Octa-dioxins
OCDF	Octa-furans
PAH	Polycyclic aromatic hydrocarbon
PB	Lead
PCDD	Penta-dioxins
PCDF	Penta-furans
PCP	Pentachlorophenol
PETN	Pentaerythritol tetranitrate
PHANTR	Phenanthrene
PHENOL	Phenol
PO4	Phosphate
PPDDD	2,2-Bis(para-chlorophenyl)-1,1-dichloroethane
PPDDE	2,2-Bis(para-chlorophenyl)-1,1-dichloroethene
PPDDT	2,2-Bis(para-chlorophenyl)-1,1,1-trichloroethane
PYR	Pyrene
RDX	Cyclonite/Hexahydro-1,3,5-trinitro-1,3,4-triazine
SB	Antimony
SE	Selenium
SO4	Sulfate

TCDD	Tetra-dioxins
TCDF	Tetra-furans
TCLEE	Tetrachloroethylene/Tetrachloroethene
TETRYL	Tetryl
TL	Thallium
TPO4	Total phosphates
TRCLE	Trichloroethylene/Trichloroethene
TXYLEN	Xylenes, total combined
V	Vanadium
XYLEN	Xylenes
ZN	Zinc

EXECUTIVE SUMMARY

The Tooele Army Depot, North Area (TEAD-N), is located in the Tooele Valley about 35 miles southwest of Salt Lake City, Utah, immediately west of the town of Tooele, Utah. The primary missions of TEAD have been rebuilding and storing military vehicles and equipment and storing conventional munitions. Under the Base Realignment and Closure (BRAC), the vehicle and equipment maintenance and storage mission will be eliminated by June 1997, although munition storage will continue. While pursuing these missions, hazardous waste or constituents of hazardous waste have been handled, treated, or disposed of at numerous locations around TEAD-N. Wastes generated include dust and ash, which contain elevated metals and organic compounds from incinerating munitions and packaging materials; ash and debris, which contain elevated metals and explosives from open burning and open detonation of propellants and munitions in unlined pits and burn pans; and used motor oil, waste solvents, and other industrial wastes. In addition to these process-specific wastes, elevated concentrations of pesticides, metals, and organic compounds also are present in areas where pesticide residues, used oil, industrial wastewater, and bulk wastes have been handled, stored, or discharged.

Under the terms of the Resource Conservation Recovery Act (RCRA), Corrective Action Permit UT3213820894 was prepared by the State of Utah Department of Environmental Quality, and signed by TEAD on January 7, 1991. The permit requires TEAD to investigate 54 solid waste management units (SWMUs) to determine if hazardous wastes or other constituents have been released to the environment and, if so, whether the release(s) pose unacceptable risks to either human or environmental health. For regulatory purposes, the SWMUs were divided into three groups to implement the Corrective Action Permit. Nine of the SWMUs *known* to have released contaminants to the environment composed one group, and 28 SWMUs *suspected* of having released contaminants were placed in another group. The 17 remaining SWMUs were included in a Federal Facility Agreement (FFA), signed on September 16, 1991 by the State of Utah, EPA, and TEAD.

Twenty of the SWMUs suspected of having released hazardous waste or hazardous waste constituents to the environment were the subject of a Phase I RCRA Facility Investigation (RFI) conducted from late 1991 through 1993. Based on the results of the Phase I RFI, the suspected releases SWMUs were further divided into Group A and Group B for a Phase II RFI. In 1994, eight additional suspected releases SWMUs were identified. Seven of these were designated the Group C SWMUs, and the eighth was added to the Group A category. The Group A suspected releases SWMUs are the eight SWMUs that are considered to have the highest potential for impacting human and environmental health. These eight SWMUs are the subject of this Phase II RCRA facility investigation.

The objective of the Phase II RFI at TEAD was to determine the areal and vertical extent of hazardous waste or constituents released from the Group A suspected releases SWMUs (Group A SWMUs); evaluate risks posed to human and environmental health because of these releases; and based on the risks, determine the need for corrective action

according to the promulgated protection standards applicable to TEAD. Background information and environmental sampling data collected during both the Phase I and Phase II RFIs was compiled to evaluate the human and environmental risks at each of the Group A SWMUs. Results of the sampling programs identified elevated metals, explosives, semi-volatile organic compounds, and dioxins and furans as contaminants. The assessment of risks to human health found estimated cancer risks greater than 1 in 10,000 for seven of the eight Group A SWMUs and between 1 in 10,000 and 1 in a million for the remaining SWMUs. Risk factors greater than 1, due to noncarcinogenic chemicals, were identified at all of the SWMUs included in this investigation and risks due to elevated blood lead levels were also identified at two of the eight SWMUs. Physical injury risks due to the possible presence of explosive ordnance items were identified at two Group A SWMUs. Finally, potential risks to the environment (which were evaluated partially quantitatively and partially qualitatively), were identified at two Group A SWMUs.

Based both on the risk assessments and the regulatory status, SWMUs 1 and 1d (the Main Demolition Area and Propellant Burn Pans) are recommended for no further action under RCRA corrective action and SWMUs 1b, 1c, 20, 21, 34, 37, 42, 45, and 48 (the Burn Pad, Trash Burn Pits, AED Deactivation Furnace Site, Deactivation Furnace Building, Pesticide Handling and Storage Area, Contaminated Waste Processing Plant, Bomb Washout Building, Stormwater Discharge Area, and the Old Dispensary) are recommended for a Corrective Measures Study to evaluate remedial alternatives and mitigate future risks to human and environmental health. Fencing portions of SWMU 42 has already been performed as an interim remedial action to mitigate potential current risks to human health.

1.0 INTRODUCTION

1.0.0.1. This report presents the data, conclusions and recommendations of a Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) conducted at eight solid waste management units (SWMUs) at the Tooele Army Depot, North Area, Utah (TEAD-N). Most of the information contained in this report was generated during two phases of the RFI conducted by the U.S. Army Environmental Center (USAEC) and its prime contractor Montgomery Watson. Phase I began in late 1991 and culminated in 1993 with a Phase I RFI report (MW, 1993). Phase II began during 1992 and this report represents its conclusion. Supplemental information contained herein was taken from previous environmental investigations, which have been conducted by the Army and its consultants since 1979 to determine the nature and extent of contamination resulting from the storage, treatment, and disposal of hazardous waste and hazardous waste constituents at various locations on the Depot.

1.0.0.2. This RFI was conducted by USAEC and its contractors on behalf of TEAD to comply with the requirements of the State of Utah. Montgomery Watson's work has been performed under Task Orders 0004 and 0006 of Contract DAAA-15-90-D-0011.

1.1 REGULATORY BACKGROUND

1.1.0.1. After groundwater contamination resulting from disposal of hazardous wastes at TEAD-N was discovered, a consent decree was issued in 1986 to TEAD by the United States District Court for the District of Utah. The terms required that TEAD conduct an assessment of the groundwater quality, close an industrial wastewater lagoon and associated wastewater ditches, develop groundwater cleanup levels, and prepare a Corrective Action Plan addressing remediation of contaminated groundwater. The terms of the Corrective Action Plan are specified in a Corrective Action Permit signed by the Utah Department of Environmental Quality (UDEQ) (formerly the Department of Health) and TEAD on January 7, 1991. In addition to requiring a clean up of the groundwater, Module VII of the Corrective Action Permit requires that TEAD conduct corrective action investigations at a number of SWMUs at TEAD-N. UDEQ and the U.S. Environmental Protection Agency (EPA) divided the 46 SWMUs identified at that time into three groups to implement the permit. Nine of the SWMUs known to have released contaminants to the environment comprise one group. Twenty SWMUs suspected of having released contaminants were placed in another group, and the remaining 17 SWMUs were included in a Federal Facility Agreement (FFA), signed on September 16, 1991 by the State of Utah, EPA and TEAD.

1.1.0.2. The twenty SWMUs suspected of having released hazardous waste or hazardous waste constituents to the environment were the subject of a Phase I RFI field investigation conducted by Montgomery Watson during the summer of 1992. Based on the results of this Phase I RFI (MW, 1993), four SWMUs were recommended for no further action under the Corrective Action Permit and the rest were qualitatively prioritized for further work based on degree and type of contamination. The seven SWMUs assigned the highest priority, based on Montgomery Watson and USAEC's judgment, are the subject of this Phase II RFI and are collectively referred to as the Group A SWMUs (Table 1-1). SWMU 1a was not included in Table 1-1 because, during the Phase I RFI, SWMU 1a was found to have only sporadic low levels of contamination. Since this SWMU is physically contained within the larger Main Demolition Area (SWMU 1), it was addressed within the context of SWMU 1 and was not investigated separately during Phase II activities. An eighth SWMU was added to this group midway through the Phase II RFI when regulatory review identified a previously uninvestigated facility.

1.1.0.3. The remaining suspected releases SWMUs, designated the Group B SWMUs, are being addressed under a separate contract. In 1994, seven additional suspected releases SWMUs were identified. All are located within the Base Realignment and Closure (BRAC) parcel and will be investigated as the Group C SWMUs under a separate contract.

1.2 PHASE II RFI OBJECTIVE, PURPOSE, AND SCOPE

1.2.0.1. Objective and Purpose. As stated in the Corrective Action Permit, the objective of the Phase I RCRA Facility Investigation is to document a release or absence of a release of hazardous waste or hazardous constituents from each SWMU. The objectives of the Phase II RCRA Facility Investigation are to further characterize the environmental setting at TEAD-N; define the source(s) and degree and extent of contamination; quantify the risks to actual and potential receptors; and, based on those risks, make recommendations for no further action or a corrective measures study (CMS). To meet these objectives, the purpose of this Phase II RFI report is to evaluate all the available background and environmental information for each of the eight Group A SWMUs. This includes all applicable data generated during the Phase II investigation, as well as the previously generated Phase I data. Conclusions regarding the degree and extent of contamination are reached and actual and potential receptors are identified. Finally, recommendations are made based on the human health and ecological risks.

TABLE 1-1

GROUP A SOLID WASTE MANAGEMENT UNITS (SWMUs)

SWMU	Description	General Location	Comment
1	Main Demolition Area	SW Corner of TEAD-N	Subarea within the Open Burning/Open Detonation Areas currently used for open detonation of munitions
1b	Burn Pad	SW Corner of TEAD-N	Subarea within the Open Burning/Open Detonation Areas. Used for open burning of propellant in the past
1c	Trash Burn Pits	SW Corner of TEAD-N	Subarea within the Open Burning/Open Detonation Areas. Used to burn and bury dunnage in the past
1d	Propellant Burn Pans	SW Corner of TEAD-N	Subarea within the Open Burning/Open Detonation Areas. Currently used to burn propellants.
20	AED Deactivation Furnace Site	West of Ordnance Area	Buildings 1351, 1352, and 1356. Used to test ammunition deactivation equipment.
21	Deactivation Furnace Building	West of Ordnance Area	Building 1320. Used to demilitarize small arms munitions.
34	Pesticide Handling and Storage Area	Maintenance Area	Building 518. Used to store, batch, and load pesticides and herbicides.
37	Contaminated Waste Processing Plant	West of Ordnance Area	Building 1325. Permitted to incinerate PCP-treated wooden packaging materials.
42	Bomb Washout Building	North End of Administration Area	Building 539. Used in the past to reclaim small arms munitions.
45	Stormwater Discharge Area	Between Administration and Maintenance Areas	Small unlined pond that receives runoff from the administration area.
48	TEAD-N Dispensary	Administration Area	Former site of Building 400. Housed medical and dental x-ray rooms.

SWMU numbering corresponds to that used in Table 8, Solid Waste Management Units with Suspected Releases, of Module VII of RCRA Corrective Action Permit UT3213820894 for the Tooele Army Depot North Area, with the exception of SWMU 1d and SWMU 48, which were subsequently added to this list.

1.2.0.2. Phase II RFI Scope. According to the terms of Task Order 0006, Montgomery Watson was requested to conduct a Phase II RFI at each of the eight Group A SWMUs. The scope of work for the Phase II RFI consists of three main elements. First, a comprehensive set of project work plans was prepared. These included the:

- Project Management Plan (PMP)
- Data Collection Quality Assurance Plan (DCQAP)
- Health and Safety Plan (HASP)
- Data Management Plan (DMP).

The next element was an extensive field investigation in which environmental samples were collected from each of the eight Group A SWMUs and from other areas in conjunction with several facility-wide sampling programs. The final element in the Phase II RFI is the preparation of this RCRA Facility Investigation summary report.

1.3 ORGANIZATION OF THIS REPORT

1.3.0.1. The information presented in this report has been organized in accordance with the *Interim Final RCRA Facility Investigation (RFI) Guidance* (USEPA, 1989). Volume I of the Phase II RFI (this volume) contains 17 text sections, as follows: Section 1.0 is the Introduction, Section 2.0 is a description of the TEAD-N facility, and Section 3.0 is a summary of the previous environmental investigations conducted at TEAD-N and a description of the RFI methodology. Section 4.0 presents a discussion of background soil and groundwater conditions and a discussion of practical quantitation limits versus the USAEC contract reporting limits and how they are treated in this investigation. Sections 5.0 through 15.0 contain contamination characterizations and risk assessments for each SWMU included in this study. Section 16.0 is a summary of the Protection Standards for TEAD-N. Section 17.0 presents a summary of the RFI conclusions, and recommendations for corrective actions.

1.3.0.2. Volumes II and III of this report consist of several appendices that include the raw data and field methodologies generated by Montgomery Watson and its subcontractors. In addition to raw data, each appendix is prefaced by a brief description of the type(s) of data presented and its organization.

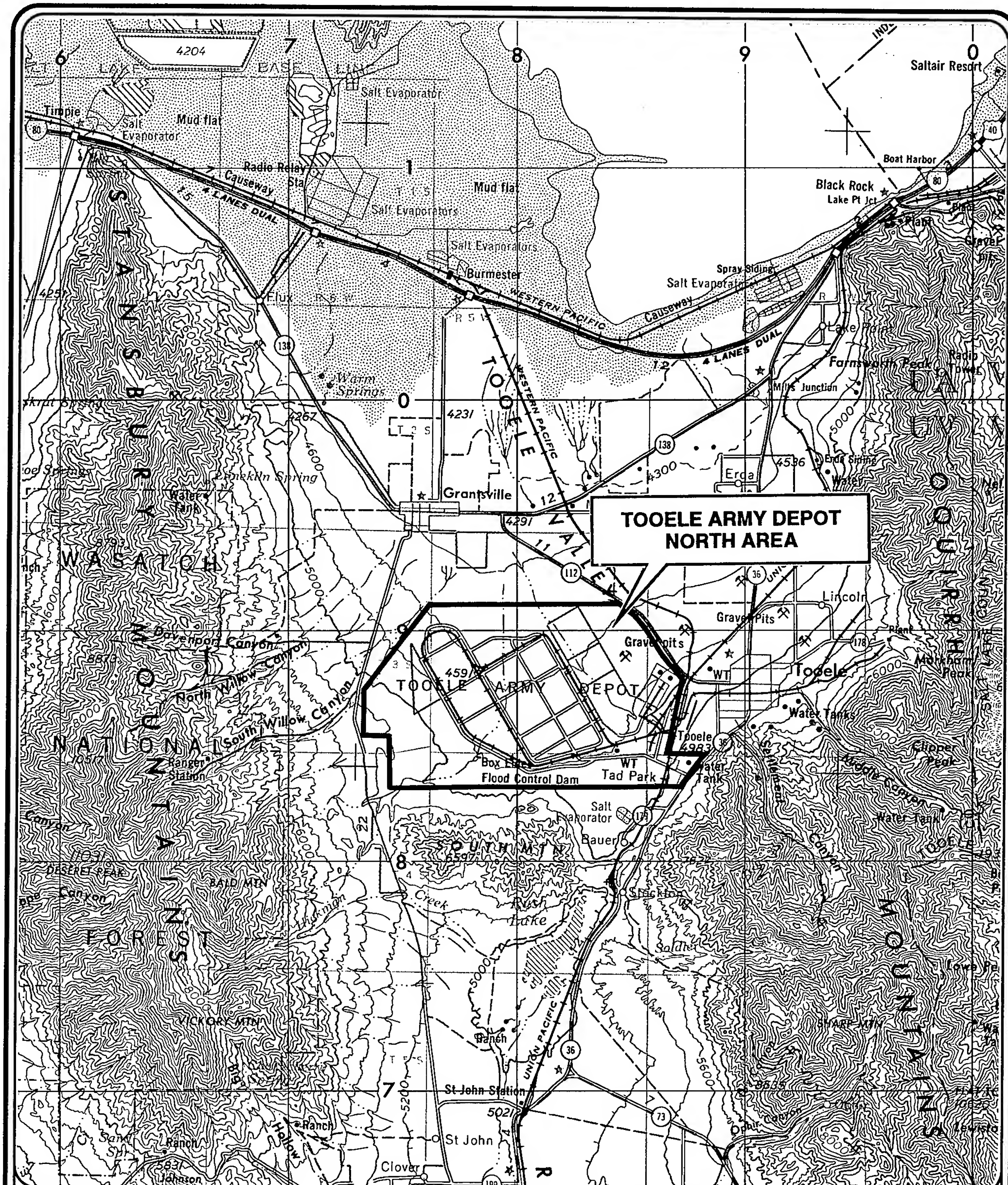
2.0 INSTALLATION DESCRIPTION

2.0.0.1. The following section presents the general facility description, background, and regional physical setting of TEAD-N and provides the framework under which the Phase I and Phase II RFI activities were conducted. Included in Section 2.0 is a description and brief history of the TEAD-N facility and surrounding communities, as well as discussions of the geographic setting, geology, soils, hydrology, hydrogeology, demography, land use, and ecology of the TEAD-N area. Most of these topics have been well documented in previous investigations, particularly in the *Groundwater Quality Assessment Engineering Report to the Tooele Army Depot, Utah,* prepared by JMM (JMM, 1988), and the *Tooele Army Depot, Preliminary Assessment/Site Investigation Final Draft Report, Volume I - North Area,* prepared by EA Engineering, Science and Technology, Inc. (EA, 1988). These reports comprehensively assess the regional hydrology, geology, and hydrogeology of the TEAD-N area. Much of the information in the following sections is taken from these two reports.

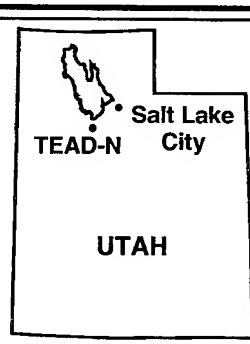
2.1 FACILITY DESCRIPTION AND HISTORY

2.1.0.1. TEAD-N encompasses 24,732 acres in the Tooele Valley in Tooele County, Utah (Weston, 1990). It is located approximately 17 miles north of the Tooele Army Depot, South Area (TEAD-S) and 35 miles southwest of Salt Lake City. The Tooele Valley is bounded to the south by the Stockton Bar and South Mountain, to the west by the Stansbury Mountains, to the east by the Oquirrh Mountains, and to the north by an open agricultural area that extends to the Great Salt Lake. The city of Grantsville (1991 population 4,500) is approximately 2 miles north of TEAD-N, and the city of Tooele (1991 population 13,887) is located immediately to the east. The location of TEAD-N is depicted in Figure 2-1.

2.1.0.2. TEAD-N was established as the Tooele Ordnance Depot on April 7, 1942, by the U.S. Army Ordnance Department. During World War II, TEAD was a backup depot for the Stockton Ordnance Depot and Benicia Arsenal, both in California. Vehicles, small arms, and other equipment for export were stored at TEAD. It was redesignated as TEAD-N in August 1962. The developed features of TEAD-N may be grouped into four main areas: (1) the ammunition storage igloos and magazines, (2) the administrative buildings, (3) the industrial maintenance area, and (4) the open revetments. Figure 2-2 depicts the topography of the TEAD-N facility, the location of the eight SWMUs included in this study, and the general areas described above.



Source: USGS Tooele, Utah 1° x 2° Quadrangle, 1970



0 1 2 3 4 5

Scale in Miles

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs

SITE LOCATION MAP

FIGURE 2-1

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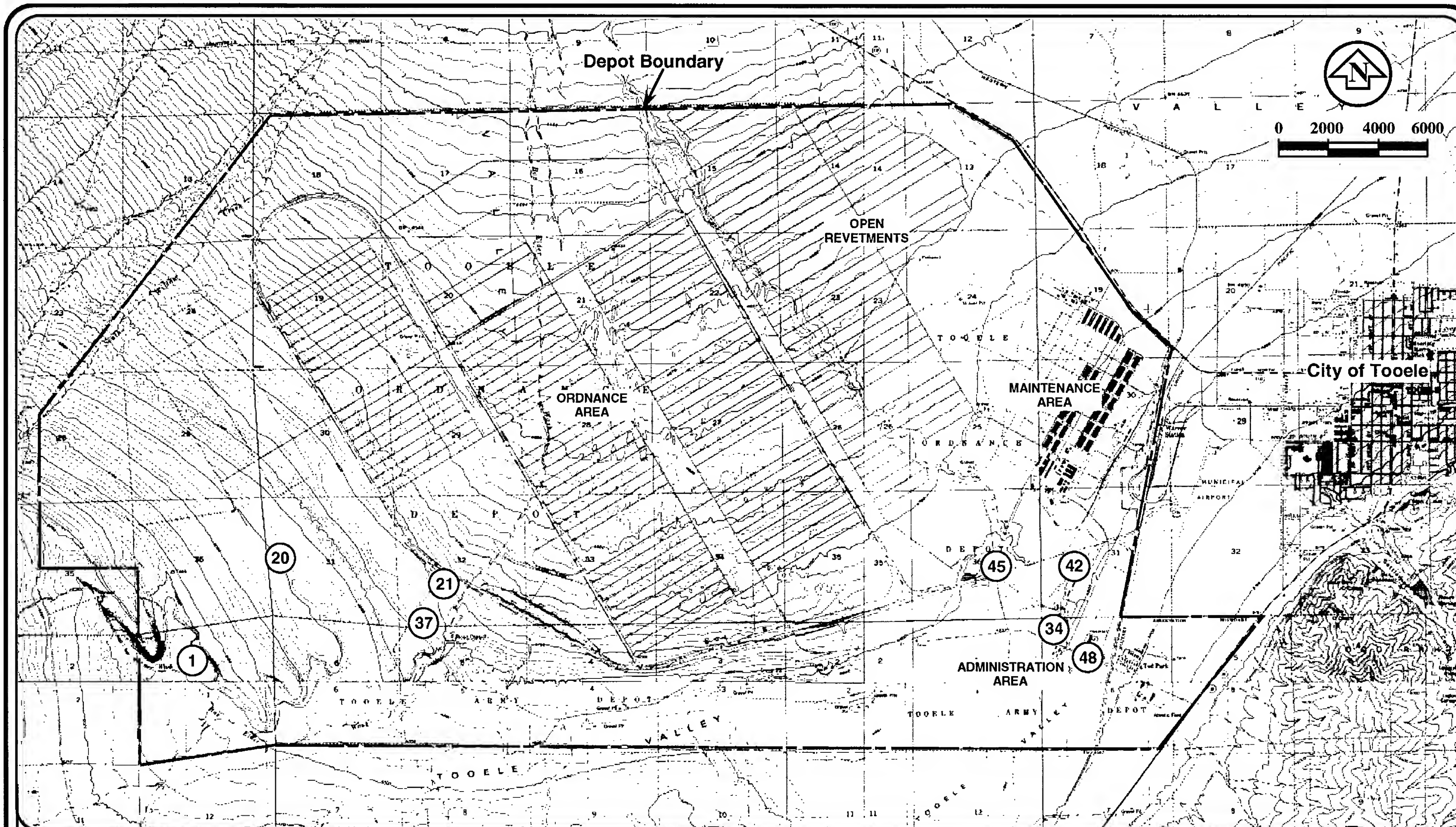


EXPLANATION

Access roadways
Elevation contour line (4900)
Intermittent stream bed

(1) Open Burning/Open Detonation Areas
(20) AED Deactivation Furnace Site
(21) AED Deactivation Furnace Building
(34) Pesticide Handling and Storage Area
(37) Contaminated Waste Processing Plant
(42) Bomb Washout Building
(45) Stormwater Discharge Areas
(48) Old Dispensary—Building 400

MONTGOMERY WATSON

TEAD N RFI—GROUP A SWMUs
SWMU LOCATION MAP
FIGURE 2-2

2.1.0.3. The Tooele Army Depot (North and South Area combined) is one of the major ammunition storage and equipment maintenance installations in the U.S. and supports other Army installations throughout the western United States. The current mission of TEAD-N is to receive, store, issue, maintain, and dispose of munitions; to provide installation support to attached organizations; and to operate other facilities, as assigned. Its major functions include the following:

- Supply, distribute, and store general supplies and ammunition
- Store strategic and critical materials
- Maintain ammunition and general supplies for TEAD-N
- Demilitarize ammunition
- Supervise training of assigned units and provide logistical support and training assistance to U.S. Army Reserves
- Design, manufacture, procure, store, and test ammunition equipment
- Repair, maintain, and store military vehicles.

2.2 GEOGRAPHIC SETTING

2.2.0.1. TEAD-N is located in the southern portion of Tooele Valley. Tooele Valley is bounded on the north by the Great Salt Lake at an elevation of approximately 4,200 feet above mean sea level (MSL). The eastern border of the valley is the north-south trending Oquirrh Mountains, which rise abruptly from the valley floor (at an elevation of approximately 5,200 feet above MSL) to a maximum elevation of 10,350 feet above MSL. The western border of the Tooele Valley is formed by the Stansbury Mountains, which reach a maximum elevation of 11,301 feet above MSL. South Mountain, a relatively low-lying, east-west trending structure, and the Stockton Bar, a Lake Bonneville Pleistocene depositional feature, bound the valley on the south, separating Tooele Valley from Rush Valley. The geographic setting of TEAD-N is depicted in Figure 2-1.

2.2.1. Physiography and Topography

2.2.1.1. Physiography. Tooele Valley is situated in the Lake Bonneville Basin of the Basin and Range physiographic province. The Lake Bonneville Basin, typical of Basin and Range physiography, is characterized by alternating isolated, north-trending, block-faulted mountains and intermontane basins.

2.2.1.2. Topography. The topography of the Tooele Valley floor is the result of coalescing alluvial fans that were formed by debris eroded from the Oquirrh and Stansbury mountains. These fans were formed during Pleistocene time when a shallow arm of Lake Bonneville occupied the area, leaving a series of wave-cut benches and gravel bars along the margins of the valley. The most prominent example of such a bar is the Stockton Bar, a low ridge that closes the gap between the Oquirrh Mountains and South Mountain. North Tooele Army Depot is situated on coalescing alluvial fans (a bajada) formed by alluvium eroded from the southern portion of the Oquirrh Mountains.

2.2.1.3. The alluvial fans that form the valley floor in the vicinity of TEAD-N slope gently toward the north. The TEAD-N topography is characterized by a gently sloping surface dissected by a series of widely-spaced dry washes (arroyos). The average topographic gradient in the northern portion of the site is approximately 70 feet per mile, increasing to about 150 feet per mile at the southern boundary.

2.3 GEOLOGY AND SOILS

2.3.0.1. This section describes the regional geologic setting of Tooele Valley. Geologic conditions at TEAD-N are similar to those throughout the Tooele Valley. Therefore, the following description of regional geology serves as an introduction to site geology.

2.3.1. Regional Geology

2.3.1.1. The Tooele Valley is bounded by Basin and Range block-faulted mountains on three sides. The Oquirrh Mountains to the east and South Mountain to the south are composed primarily of extensively folded and faulted, alternating beds of quartzite and limestone of late Mississippian, Pennsylvanian, and early Permian Age. The composition of the Stansbury Mountains (west side of the Tooele Valley) is similar to that of the Oquirrhs, with the exception of the occurrence of Cambrian quartzite. Gravity surveys

and the many faults observed in the valley indicate that the Tooele Valley basin is probably not a single down-faulted structural depression, but is more likely a complex collection of troughs and ridges caused by several down-faulted blocks (ERTEC, 1982). The geology of the region is depicted in Figure 2-3.

2.3.1.2. Tooele Valley is filled with a thick sequence of unconsolidated sediments of Tertiary and Quaternary Age. The older Tertiary sediments comprise the Salt Lake Group and consist of moderately consolidated sand, gravel, silt, and clay with an abundance of volcanic ash (Everitt and Kaliser, 1980). The younger Quarternary sediments consist of interlayered and unconsolidated sand, gravel, silt, and clay, including sediments deposited before, during, and after the existence of Lake Bonneville. The thickness of the valley sediments ranges from a few feet at the margins of the valley to over 8,000 feet in the north central part of the valley (Everitt and Kaliser, 1980). The contact between the Tertiary and Quarternary sediments was reported to be between 800 and 900 feet below the ground surface (ERTEC, 1982).

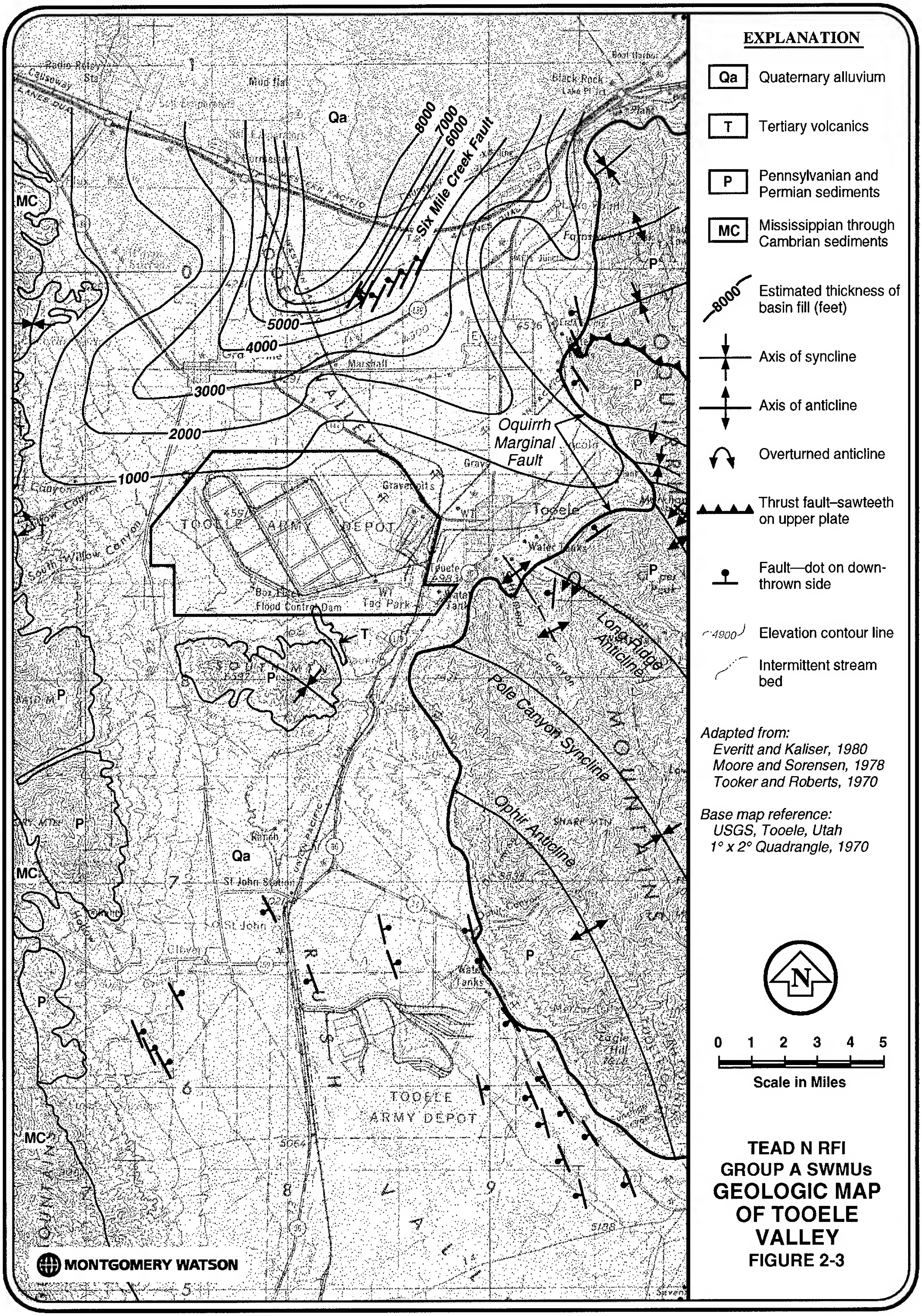
2.3.1.3. The surface of the alluvium has been shaped by inundations of Lake Bonneville. Valley topography shows evidence of wave-cut benches and shoreline erosion. The major lake levels and their dates are as follows (Currey and others, 1984):

Lake Level	Elevation (MSL)	Time Period (years ago)
• Gilbert	5,100 feet	23,000 to 20,000
• Bonneville	5,200 feet	16,000 to 14,500
• Provo	4,740 feet	14,500 to 13,500
• Stansbury	4,500 feet	11,000 to 10,000

The elevation of the ground surface in the TEAD-N area ranges from about 4,500 feet above MSL at the northern boundary to about 5,200 feet on the western boundary.

2.3.1.4. Bedrock beneath the unconsolidated sediments of the Tooele Valley consists of alternating quartzite and limestone beds similar to the late Paleozoic rocks found in the Stansbury Mountains, Oquirrh Mountains, and South Mountain.

2.3.1.5. Several potentially active faults were identified in the Tooele Valley by Everitt and Kaliser (1980); two of these faults are located near TEAD-N (Figure 2-3). The Oquirrh marginal fault was observed along the base of the Oquirrh Mountains, just east



TEAD N RFI
GROUP A SWMUs
GEOLOGIC MAP OF TOOELE VALLEY
FIGURE 2-3

PROJECT NO. 2942.0190

of the City of Tooele. Evidence of post-Lake Bonneville (less than 18,000 years ago) and Holocene (or Recent) displacement (less than 10,000 years ago) was interpreted from fault scarps south of Middle Canyon and northward to Bates Canyon and Lake Point. Post-Holocene movement was also interpreted from scarps along the Six-Mile Creek fault north of Grantsville. These faults are the likely result of Basin and Range extension.

2.3.2. Site Geology

2.3.2.1. TEAD-N occupies the southern portion of the Tooele Valley. The valley fill consists of silt, sand, gravel, and cobbles composed of quartzite, sandstone, and limestone eroded from the Oquirrh and Stansbury Mountain ranges. Based on previous investigations, geologic conditions beneath TEAD-N are similar to those found elsewhere in the Tooele Valley, with unconsolidated alluvial sediments overlying Paleozoic limestone, quartzite, and sandstone formations.

2.3.2.2. Alluvial Deposits. The unconsolidated quartzite, sandstone, and limestone alluvium underlying TEAD-N is typical of alluvial fan deposits, consisting of poorly-sorted clayey and silty sands, gravels, and cobbles. Lateral changes in the coarseness of the granular sediments are apparent across TEAD-N. In general, the sediments on the east and west margins of the Depot are coarse, silty gravels with some cobbles and boulders. The coarse-grained layers are composed of fine and coarse gravels with varying fractions of sands and cobbles, and they comprise aquifer zones when saturated. By contrast, sediments beneath the central and northern parts of the depot are silts, fine sands, and gravels. Soils are typically yellowish brown to grayish orange with varying amounts of brown, yellow, and orange quartzite and dark gray limestone clasts.

2.3.2.3. Erosion and deposition of the alluvium was influenced by climate, precipitation rates, and periods of inundation by Lake Bonneville. As a result, the alluvial sediments have been reworked, and alluvial units that may have been deposited contemporaneously may not appear to be the same unit. Consequently, lithologic correlation between alluvial units is difficult. However, continuous fine-grained layers (silty clays and clayey silts) have been observed in soil borings at TEAD-N (JMM, 1988).

2.3.2.4. Six fine-grained layers have been identified during previous investigations at TEAD-N and have been estimated to range from less than 10 feet to more than 70 feet thick. The fine-grained layers are composed of varying fractions of clayey silt, silty clay, and silty, fine to coarse sand. Because the permeability of the fine-grained materials is

low, they can act as barriers to groundwater movement. These fine-grained layers are believed to be areally continuous, and they maintain different hydraulic heads between different water-bearing zones beneath the same location.

2.3.2.5. Evidence of bedding was also identified from seismic refraction surveys conducted by ERTEC (1982). Three distinct velocity layers were identified and interpreted to represent colluvium, uncemented conglomerate, and cemented conglomerate in order of increasing depth. Investigations by JMM (1988) also indicated that cemented gravels are present at TEAD-N. Samples from deep soil borings revealed cemented gravels at depths greater than 350 feet below ground surface (bgs) beneath the northern portion of TEAD-N and north of the TEAD-N boundary (JMM, 1988).

2.3.2.6. Although the deeper gravels are believed to be cemented, evidence from drilling indicated that the cement does not completely fill the voids between clasts. Examination of drill cutting samples from the cemented zones revealed that a rind-like calcareous coating exists on the surface of many of the gravel clasts.

2.3.2.7. Bedrock. Little bedrock is exposed at TEAD-N. Therefore, existing TEAD-N bedrock data are based on investigations at the Industrial Wastewater Lagoon (IWL) and on geophysical surveys conducted over the entire TEAD-N area. The most significant bedrock features are a series of limestone and quartzite outcrops located in the northeast part of the Depot, as depicted in Figure 2-4. Borehole and geophysical data indicate that bedrock in this area occurs as a topographically high, elongated block, oriented northeast to southwest, with deeper suballuvial flanks extending to the southwest and southeast.

2.3.2.8. Bedrock beneath TEAD-N consists of brown and gray quartzite and blue-gray and black limestone. Depths to bedrock range from surface outcrops in the northeast corner of TEAD-N to more than 2,000 feet bgs in the south-central portion of the facility. The depth to bedrock across TEAD-N is shown in Figure 2-4.

2.3.2.9. Tooele Valley has been subjected to many geologic forces throughout history. Late Cretaceous Sevier age folding, Basin and Range faulting during the Miocene and Pliocene, and eastward tilting of the Oquirrh Mountains during the Pliocene and Pleistocene have created multiple fault blocks of highly deformed Paleozoic rocks. In addition to the structural deformation, bedrock has been extensively weathered through repeated inundations by Lake Bonneville and silicified and altered by hydrothermal fluids (Tooker and Roberts, 1970).

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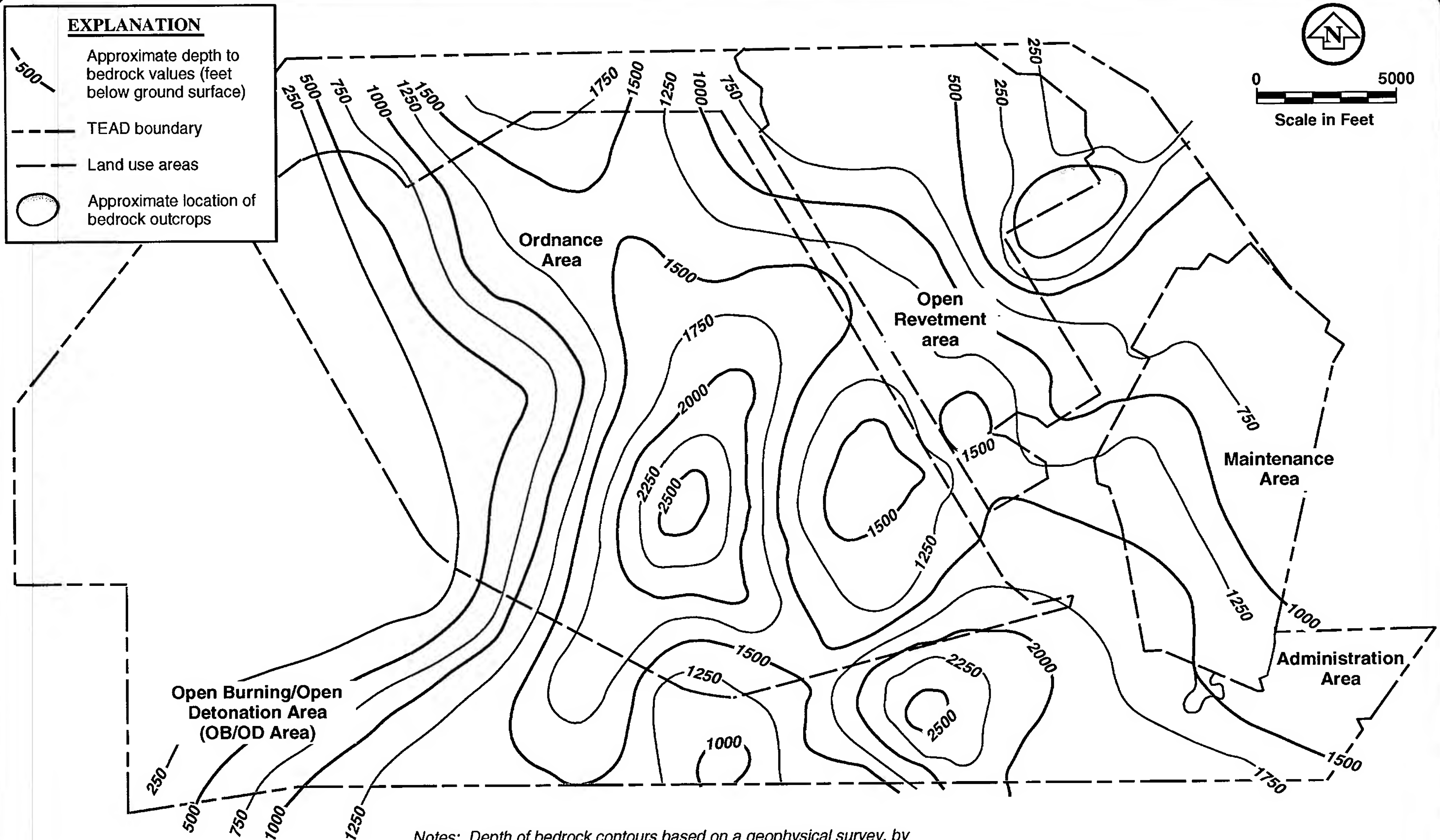

Notes: Depth of bedrock contours based on a geophysical survey, by ERTEC, (1982); Bedrock boreholes in the eastern portion of TEAD-N generally confirm the geophysical survey.

Source: Office of the Facilities Engineer, Tooele Army Depot, July 1989; ERTEC,1982

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TEAD-N RFI—GROUP A SWMUs
DEPTH TO BEDROCK CONTOUR MAP
FIGURE 2-4

2.3.2.10. Fractures measured in the bedrock outcrops during previous investigations were generally vertical or near vertical with strikes of about 30° to 50° west of north (JMM, 1988). These directions are approximately perpendicular to the bedding attitudes observed in the outcrops. Evidence of extensive bedrock fracturing was revealed during previous investigations (JMM, 1988). Specifically, the dolomite or argillaceous limestone in the area beneath the IWL and the interbedded sandstone and quartzite at the northwest end of the bedrock block showed evidence of extensive fracturing. Diamond drill cores of these beds revealed zones of open fractures and dissolution cavities that appear to have developed primarily along fracture planes. The presence of the open fractures and dissolution zones combined with the uniform groundwater elevations observed in the bedrock body during previous investigations suggest that groundwater conditions in the bedrock are largely controlled by these features (JMM, 1988).

2.3.3. Site Surface Soils

2.3.3.1. Surface soil characteristics in the TEAD-N investigation areas reflect the topographic location and the geologic materials from which they were formed. The soils consist primarily of gravelly loam, loam, or fine sand that developed in alluvial deposits or lacustrine sediments. According to unpublished soils maps of the Tooele Valley, the primary surface soils identified at TEAD-N consist of the following soil series (USSCS, 1991):

- Abela
- Berent
- Hiko Peak
- Birdow
- Taylors Flat
- Medburn
- Manassa
- Doyce.

2.3.3.2. Soils that develop in semi-arid climates do not develop strong diagnostic horizons. In general, these soils are deep, well-drained, moderately permeable, and alkaline (i.e., pH greater than 7). Water and wind erosion potentials for these soils are considered moderate and slight, respectively. The Abela, Hiko Peak, Birdow, and Medburn soil series contain inclusions of other soil types. However, the inclusions are

either intermingled with the main soil type or their area is areally too small to map independently. As a consequence, the inclusions are not identified in the major mapping units.

2.3.3.3. The most important difference between the main soil types and the inclusions is texture change (particle size). Soil particle size (percent gravel, sand, silt, and clay) is one of the principal factors determining the chemical and hydraulic properties of soil. Therefore, it is important that all soil types present at the SWMUs are included in the background soil sampling program. Table 2-1 provides a detailed description of the primary soil series and the inclusions found in each soil series mapping unit at TEAD-N. A map of the USSCS soil units present at TEAD-N and the locations of the background soil borings from the Phase I and Phase II investigations are presented in Figure 2-5.

2.4 HYDROLOGY

2.4.1. Climate

2.4.1.1. The climate of the Tooele valley is temperate and semi-arid, and is characterized by limited precipitation, hot and dry summers, cool springs and falls, and moderately cold winters. The lowest temperatures typically occur in January (monthly mean of 28° F) and the highest temperatures occur in July (monthly mean of 75° F) (EA, 1988). The mean annual air temperature at Tooele from 1941 to 1970 was 51°F. The average growing season (frost free days) is from April 1 through October 25.

2.4.1.2. Because of the location of the continental storm track, most of the precipitation in the Tooele Valley occurs as snow between the months of October and May. Summers are generally dry with occasional thundershowers. May is usually the wettest month, and June through July is the driest period. The greatest amount of precipitation occurs in the adjacent Oquirrh and Stansbury Mountains, where the average annual precipitation is more than 40 inches per year. The average annual precipitation at the City of Tooele for the period from 1897 to 1985 was 16.95 inches. At Grantsville, approximately two miles from TEAD-N, the average annual precipitation from 1957 to 1977 was 11 inches (Razem and Steiger, 1981). Gates (1965) estimated the average total amount of precipitation and stream run-off entering the Tooele Valley at about 200,000 acre-feet each year.

TABLE 2-1

GENERAL CHARACTERISTICS OF SURFACE SOIL OF TEAD-N INVESTIGATION AREA

Mapping Unit	Soil Type	Origin	General Location	Characteristics: Texture	Depth (Feet BGS)	Soil pH	Permeability	Infiltration Rate (cm/sec)
Abela Included in this unit are Borvant and Birdow soils.	Abela	Developed in alluvium derived primarily from limestone and quartzite.	Alluvial fans on 1 to 8 percent slopes at elevations of 4,600 to 6,000 feet above MSL.	Gravelly loam (GM-GC; SC-SM)	0 to 0.8	7.9 to 8.4	Mod. rapid	1.4×10^{-3} to 4.2×10^{-3}
				Very gravelly loam GC-GM)	0 to 1.7	7.9 to 9.0	Mod. rapid	1.4×10^{-3} to 4.2×10^{-3}
				Very gravelly loam to extremely gravelly sandy loam (GM-GC; GP-GM)	1.7 to 5	8.5 to 9.0	Mod. rapid	1.4×10^{-3} to 4.2×10^{-3}
	Borvant	Developed in alluvium derived predominantly from limestone.	Shallow soil over a carbonate cemented hardpan on fan terraces on short or medium length, convex, 2 to 15 percent slopes at elevations of 5,200 to 6,500 feet above MSL.	Gravelly loam (GM-GC, SC-SM)	0 to 0.5	7.4 to 9.0	Moderate	4.2×10^{-4} to 1.4×10^{-3}
				Very gravelly loam (GM-GC)	0.5 to 1.5	7.9 to 9.0	Moderate	4.2×10^{-4} to 1.4×10^{-3}
				Indurated	1.5	NA	NA	NA
Berent-Hiko Peak Complex. Included in this unit are Amtoft, Medburn, Sprager, Taylorsflat, Duneland, and Rock Outcrop soils.	Berent	Eolian sands derived from mixed rock types.	Hummocky vegetated sand dunes and fan terraces up to 30 percent slopes at elevations of 4,500 to 5,800 feet above MSL.	Loamy fine sand (SM)	0 to 0.5	7.4 to 8.4	Rapid	4.2×10^{-3} to 1.4×10^{-2}
				Fine sand (SM)	0.5 to 5	7.9 to 9.0	Rapid	Greater than 1.4×10^{-2}
	Hiko Peak	Developed in alluvium from mixed rock types.	Alluvial fan terraces on medium length, convex, 2 to 15 percent slopes at elevations of 4,400 to 6,000 feet above MSL.	Gravelly loam (GM-GC)	0 to 0.5	7.9 to 8.4	Mod. Rapid	1.4×10^{-3} to 4.2×10^{-3}
				Very gravelly loam (GM-GC)	0.5 to 1	7.9 to 9.0	Mod. Rapid	1.4×10^{-3} to 4.2×10^{-3}
				Very gravelly loam (GM-GC)	1 to 5	8.5 to 9.0	Mod. Rapid	1.4×10^{-3} to 4.2×10^{-3}
	Amtoft	Developed in alluvium derived from mixed rock types.	Rock outcrops on 30 to 70 percent slopes.	Very cobbly loam (GM-GC)	0 to 1	7.9 to 9.0	Mod. rapid	1.4×10^{-3} to 4.2×10^{-3}
				Extremely cobbly loam (GM-GC; GP-GC)	1 to 1.5	7.9 to 9.0	Mod. rapid	1.4×10^{-3} to 4.2×10^{-3}
				Unweathered bedrock	1.5	NA	NA	NA

Source: USSCS, 1991.

NA Not Available

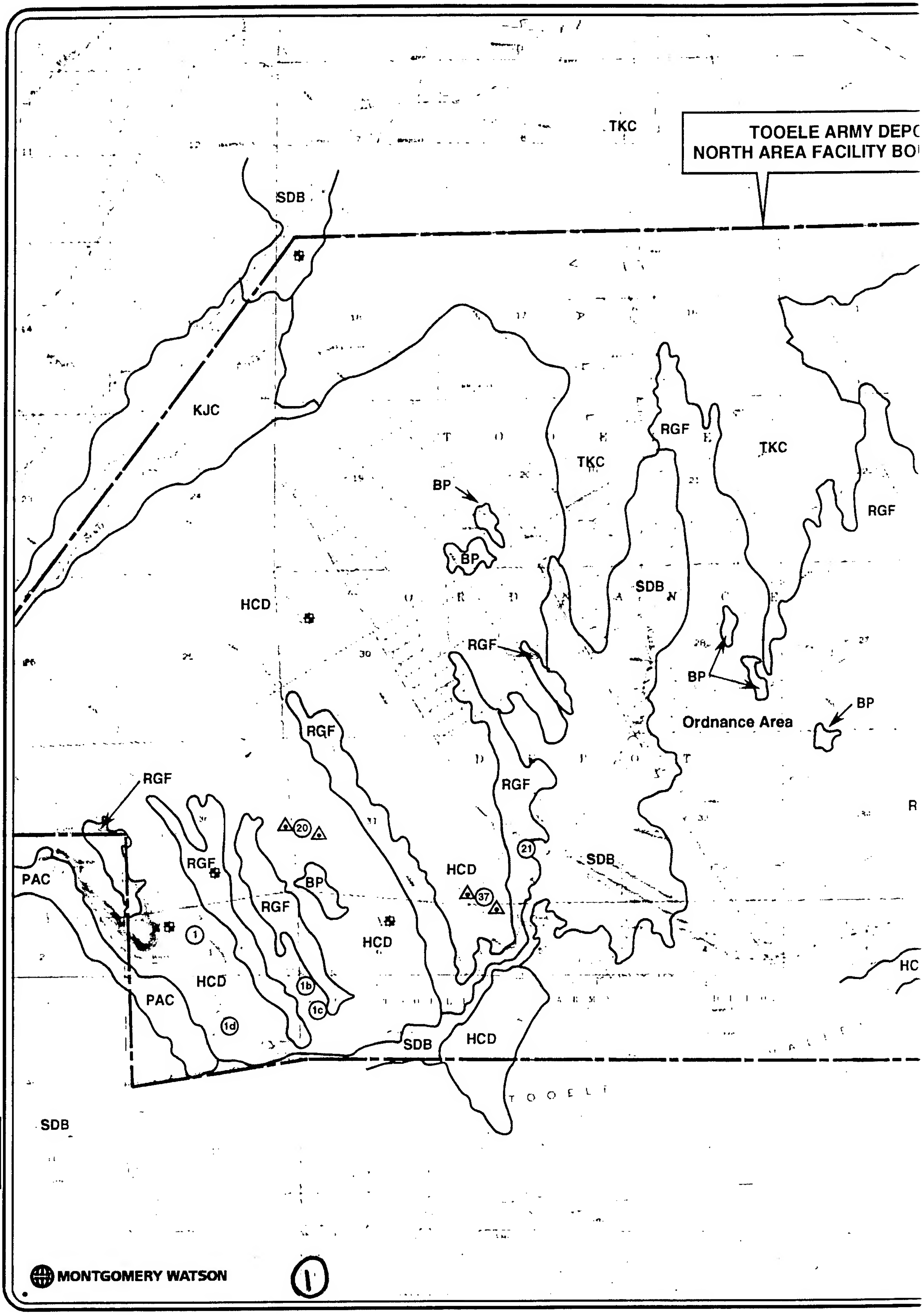
TABLE 2-1

GENERAL CHARACTERISTICS OF SURFACE SOIL OF TEAD-N INVESTIGATION AREA
(CONTINUED)

Mapping Unit	Soil Type	Origin	General Location	Characteristics: Texture	Depth (Feet BGS)	Soil pH	Permeability	Infiltration Rate (cm/sec)
	Spager	Developed in alluvium derived from limestone.	Alluvial fan terraces on 2 to 15 percent slopes at elevations of 5,200 to 6,200 feet above MSL.	Gravelly loam (GM-GC; SC-SM).	0 to 0.5	7.4 to 9.0	Mod Rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Very gravelly loam, very gravelly fine sandy loam (GM-GC).	0.5 to 2	Greater than 8.4	Mod Rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Indurated	2	NA	NA	NA
	Taylorsflat	Alluvium and lacustrine sediments derived from mixed rock types.	Lake terraces and alluvial fan terraces on medium length, linear to convex, 1 to 5 percent slopes at elevations of 5,000 to 6,000 feet above MSL.	Loam (CL-ML)	0 to 0.5	7.9 to 8.4	Mod. Slow	$4.2x10^{-4}$ to $1.4x10^{-3}$
				Loam (CL-ML)	0.5 to 1.0	7.9 to 8.4	Mod. Slow	$1.4x10^{-4}$ to $1.4x10^{-3}$
				Loam (CL-ML)	1.0 to 4	8.5 to 9.0	Mod. Slow	$1.4x10^{-4}$ to $1.4x10^{-3}$
				Loam (CL-ML)	4 to 5	8.5 to 9.0		$1.4x10^{-4}$ to $1.4x10^{-3}$
	Duneland	Sand; derived from mixed rock types.	Ridges and intervening troughs made of fine sand sized particles on lake plains and low lake terraces.	Sand (SM-SW)	NA	NA	NA	NA
	Rock outcrop	Dependent on the type of bedrock.	Exposures of barren bedrock that occur mainly on escarpments or ridges. Slopes range from 30 to 60 percent.	NA	NA	NA	NA	NA
Medburn. Included in this unit are Hiko Peak and Taylorsflat soils.	Medburn	Developed in alluvium and lacustrine sediments, derived predominantly from sedimentary rocks.	Lake terraces and alluvial fan terraces on short or medium length, convex or linear, 2 to 8 percent slopes at elevations of 4500 to 5800 feet above MSL.	Fine sandy loam (SM; SC-SM)	0 to 0.5	7.9 to 8.4	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Fine sandy loam (SM; SC-SM)	0.5 to 3.5	7.9 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
				Fine sandy loam (SM; SC-SM)	3.5 to 5	8.5 to 9.0	Mod. rapid	$1.4x10^{-3}$ to $4.2x10^{-3}$
Birdow. Included in this unit are Erda and Lakewin soils.	Birdow	Developed in alluvium derived predominantly from limestone and quartzite.	Flood plains, stream terraces, and alluvial fans on long, linear, or slightly concave 1 to 4 percent slopes at elevations from 4,250 to 6,200 feet above MSL.	Loam (CL-ML)	0 to 2.3	7.4 to 8.4	Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$
				Loam (CL-ML)	2.3 to 5	7.9 to 9.0	Moderate	$4.2x10^{-4}$ to $1.4x10^{-3}$
	Erda	Developed in alluvium and lacustrine sediments derived from mixed rock types.	Alluvial fan terraces and lake terraces on 1 to 5 percent slopes at elevations of 4,250 to 6,000 feet above MSL.	Silt loam (CL-ML)	0 to 1	7.4 to 8.4	Mod. Slow	$1.4x10^{-4}$ to $4.2x10^{-4}$
				Silt loam (CL-ML)	1 to 3	7.9 to 9.0	Mod. Slow	$1.4x10^{-4}$ to $4.2x10^{-4}$
				Silt loam , silty clay loam (CL-ML)	3 to 5	7.9 to 9.0	Mod. Slow	$1.4x10^{-4}$ to $4.2x10^{-4}$

Source: USSCS, 1991.

NA Not Available



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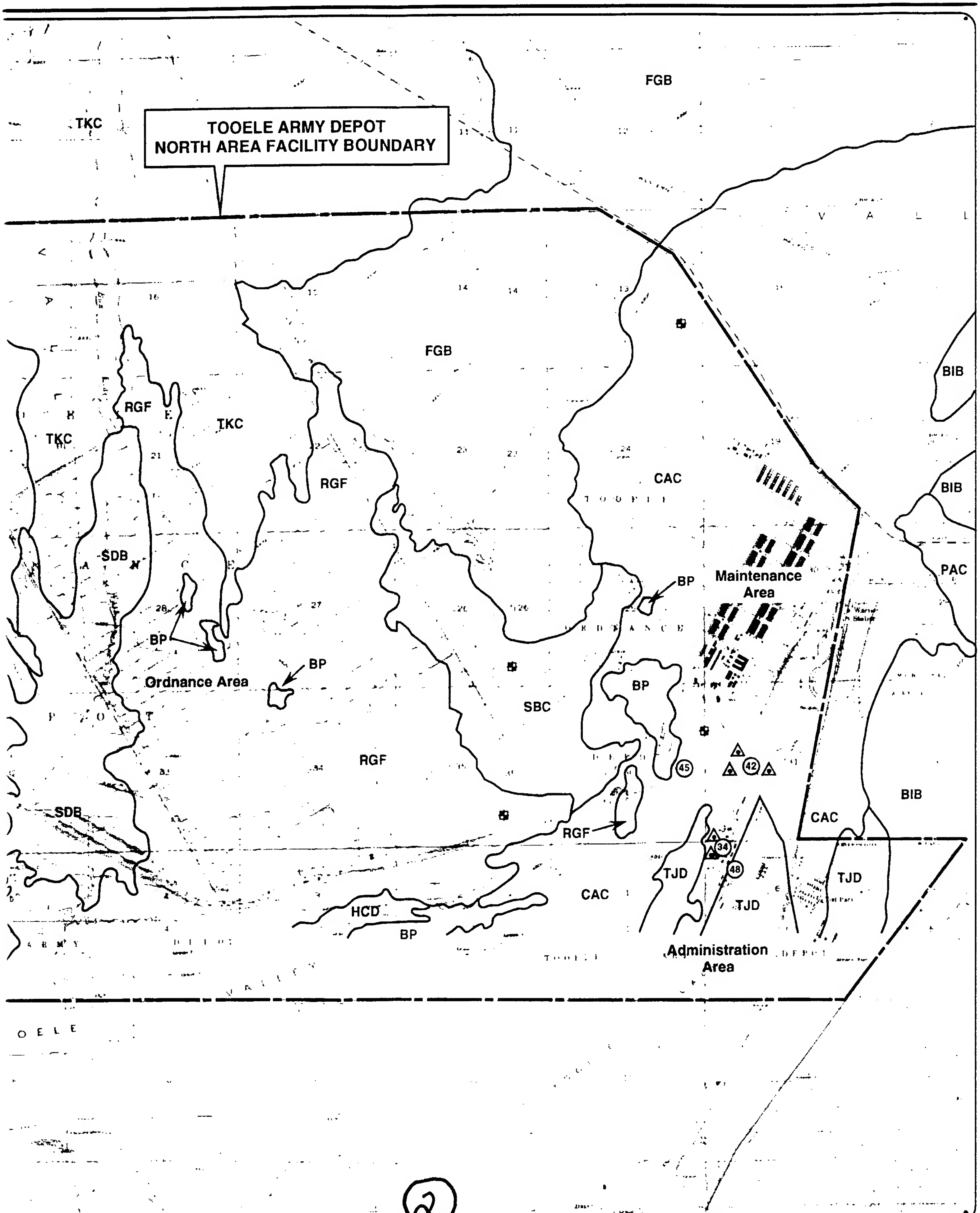
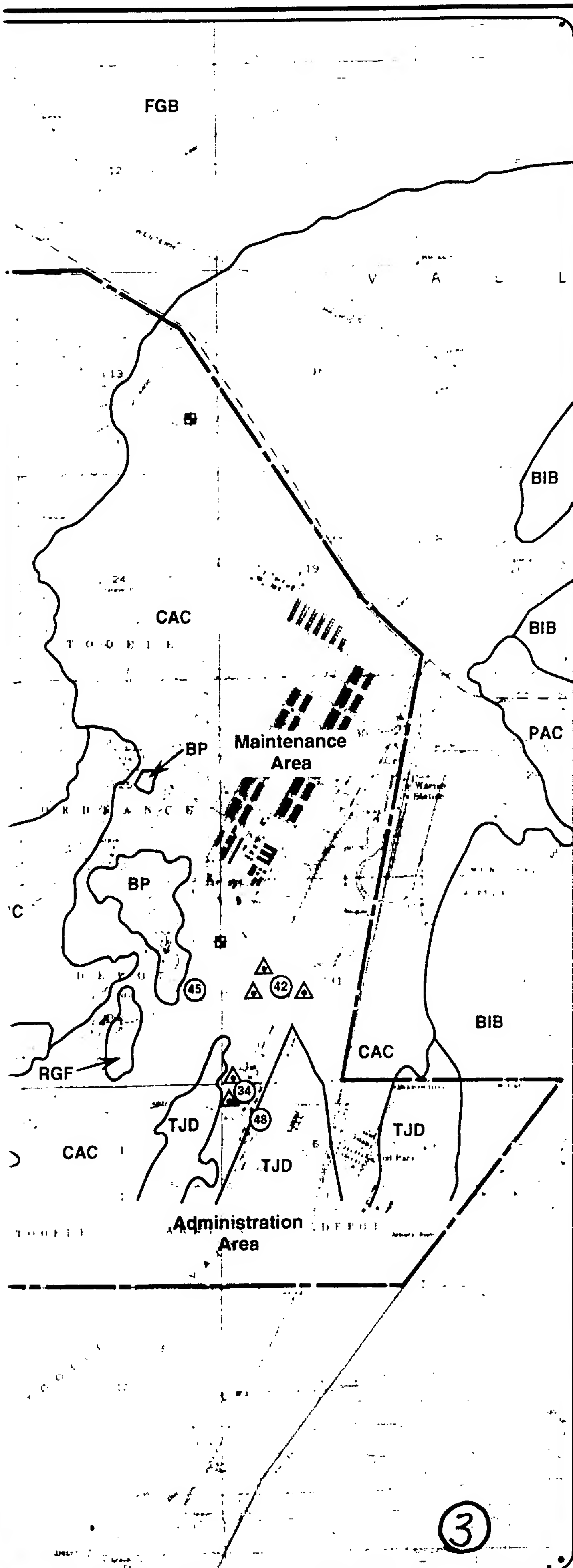

TOOELE ARMY DEPOT
NORTH AREA FACILITY BOUNDARY
FGB
TKC
RGF
SDB
BP
Ordnance Area
SBC
CAC
Maintenance Area
BIB
PAC
HCD
TJD
Administration Area
45
42
34
48

②



EXPLANATION

BP	Borrow Pits
BIB	Lakewin Series
CAC	Abela Series
FGB	Manessa Series
HCD	Hiko Peak Series
KJC	Hiko Peak — Taylorsflat Complex Series
PAC	Birdow Series
RGF	Berent — Hiko Peak Complex Series
SBC	Medburn Series
SDB	Medburn Saline Series
TJD	Doyce Series
TKC	Taylorsflat Series
	Phase I RFI background soil sample location
	Phase II RFI background soil sample location
	Elevation contour line
	Stream bed

Solid Waste Management Units (SWMVs)

1	Open Burning/Open Detonation Areas
20	AED Deactivation Furnace Site
21	AED Deactivation Furnace Building
34	Pesticide Handling and Storage Area
37	Contaminated Waste Processing Plant
42	Bomb Washout Building
45	Stormwater Discharge Area
48	Old Dispensary Discharge—Building 400

Source: USSCS, 1991

N

0 4000

Scale in Feet

TEAD N RFI—GROUP A SWMUs

SOIL TYPE AND BACKGROUND SOIL BORING LOCATION MAP

FIGURE 2-5

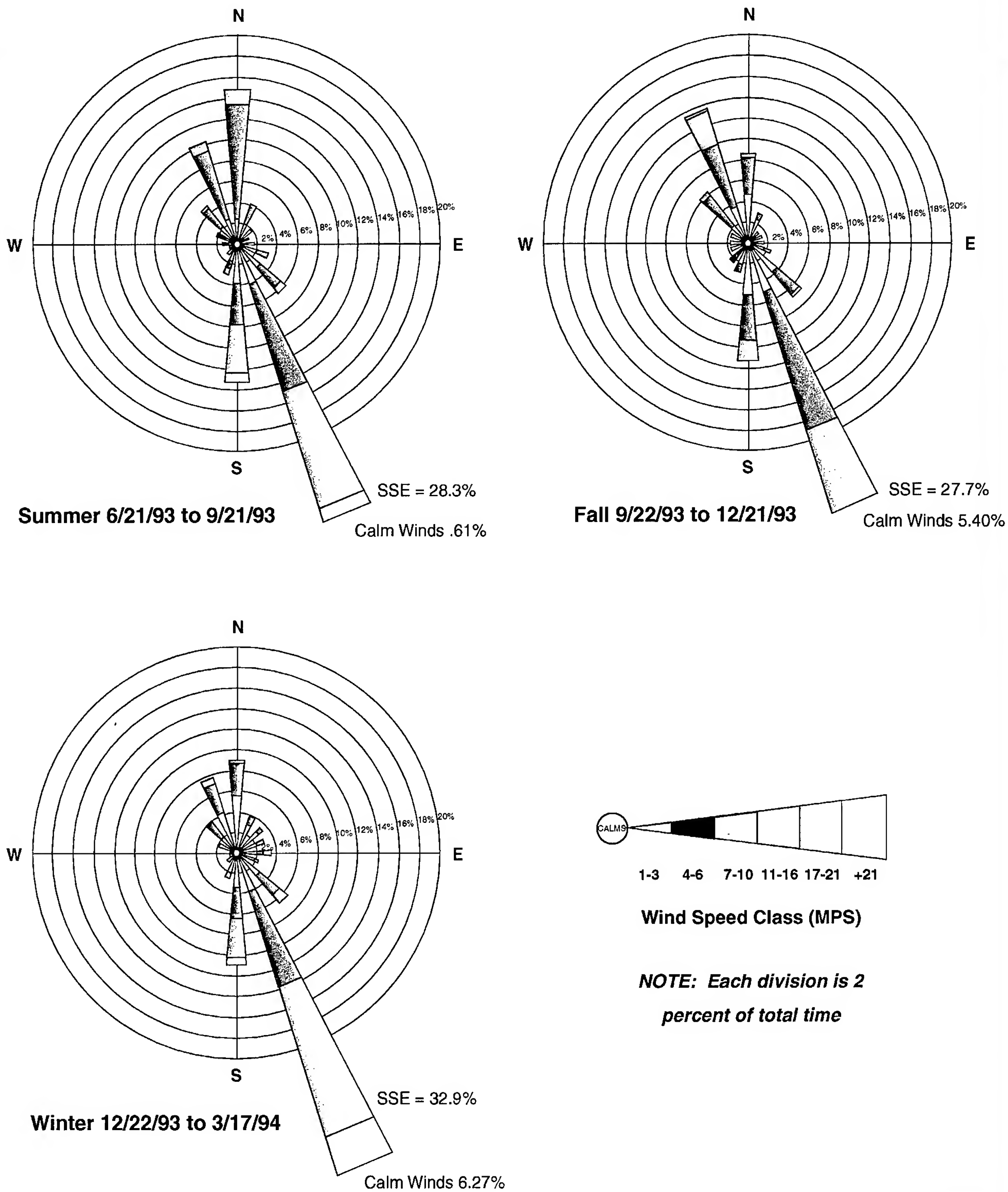
2.4.1.3. Classical sea breeze circulation exists in the Salt Lake Basin, which includes the Tooele Valley, due to the presence of the Great Salt Lake (EA, 1988). The predominant mechanism causing air movement is diurnal temperature changes. As the surface temperature of the land increases during the day, (compared to the temperature of the lake) the winds generally blow upslope, from north to south (away from the lake), into the valley and mountains. As the land temperature cools (compared to the temperature of the lake) during the night, the wind direction reverses and moves downslope (toward the lake), from south to north.

2.4.1.4. Figure 2-6 shows several "wind roses" of wind directions and velocities for the TEAD-N area. These data were collected from data gathered by Rust Environment and Infrastructure (RUST, 1994a) during a 19-month period in 1993 and 1994. The location of the weather station was near the closed industrial wastewater lagoon in the eastern part of TEAD-N. These wind roses show the general north-south nature of the prevalent winds at TEAD-N (i.e., away from and toward the Great Salt Lake).

2.4.2. Surface Water Hydrology

2.4.2.1. There are five perennial streams in the Tooele Valley, with a total discharge of approximately 17,000 acre-feet of water per year (Razem and Steiger, 1981). These streams originate in the mountains above the Tooele Valley in response to rapid snowmelt and summer thunderstorms. Two streams originate in the central Oquirrh Mountains at the eastern side of the valley and enter the valley near Tooele, the other three originate in the central Stansbury mountains on the western side of the valley.

2.4.2.2. No perennial streams exist at TEAD-N, although the western border is cut by the drainages from South Willow and Box Elder Canyons. South Willow Creek, near the northwest boundary of TEAD-N, is the largest stream in the Tooele Valley with an annual flow of approximately 4,830 acre feet. Box Elder Wash, which crosses TEAD-N from south/southwest to north, is an ephemeral stream that has an annual discharge of approximately 900 acre feet. Except during rare periods of heavy rain or rapidly melting mountain snowpacks, surface water flow from South Willow drainage or Box Elder drainage does not occur at TEAD-N. The surface waters from these drainages are either diverted for irrigation shortly before or after they leave the canyons or the waters infiltrate directly into the unconsolidated deposits near the mountain fronts.



SOURCE: RUST (1994a)

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs

24-HOUR WIND ROSES

FIGURE 2-6

PROJECT NO. 2942.0190

2.4.2.3. Artificial drainage systems have been constructed at TEAD-N to control storm runoff. These systems terminate in spreading areas or in natural drainage channels. Near the industrial area, surface water runoff is to the west and southwest until it reaches the central part of the valley, and then it flows in a more northwesterly direction. Runoff from the area near the former wastewater ditches flows to the west for a few hundred yards and then follows a northwesterly route.

2.4.2.4. Evapotranspiration. A large portion of precipitation in the Tooele Valley is transpired by plants and evaporated from soils. Gates (1965) reported a potential annual evapotranspiration rate of 40,000 acre-feet in the Tooele Valley. Potential evapotranspiration exceeds precipitation in every month except November, December, and January, leaving about 10 percent of the annual precipitation as potential recharge (JMM, 1988). A more detailed investigation by Razem and Steiger (1981) indicated that evapotranspiration is approximately 23,000 acre-feet per year.

2.5 HYDROGEOLOGY

2.5.1. Regional Hydrogeology

2.5.1.1. Most of the groundwater in the Tooele Valley occurs in the valley fill deposits and to a lesser extent in the underlying bedrock. Because the valley fill deposits are generally coarse-grained, they form a productive aquifer system when saturated. Although little is known about the water-bearing characteristics of the bedrock aquifer, it is important to the Tooele Valley hydrogeologic system because it serves as a source of underflow to the alluvial valley fill along the margins of the Tooele Valley (JMM, 1988).

2.5.1.2. The alluvial aquifer is primarily composed of gravels with major interbeds consisting of varying amounts of sands, silts, and clays. Although the gravels vary in composition, they generally consist of quartzite fragments with minor limestone, sandstone, and igneous fragments. The alluvium ranges in thickness from zero feet at the basin margin to over 8000 feet in the north central part of Tooele Valley (Everitt and Kaliser, 1980). At the northern TEAD-N boundary, the alluvium thickness is approximately 780 feet (EA, 1988).

2.5.1.3. The bedrock aquifer consists primarily of quartzite and limestone of low primary permeability. However, secondary permeability can be relatively high where fractures and solution openings occur in the bedrock (JMM, 1988).

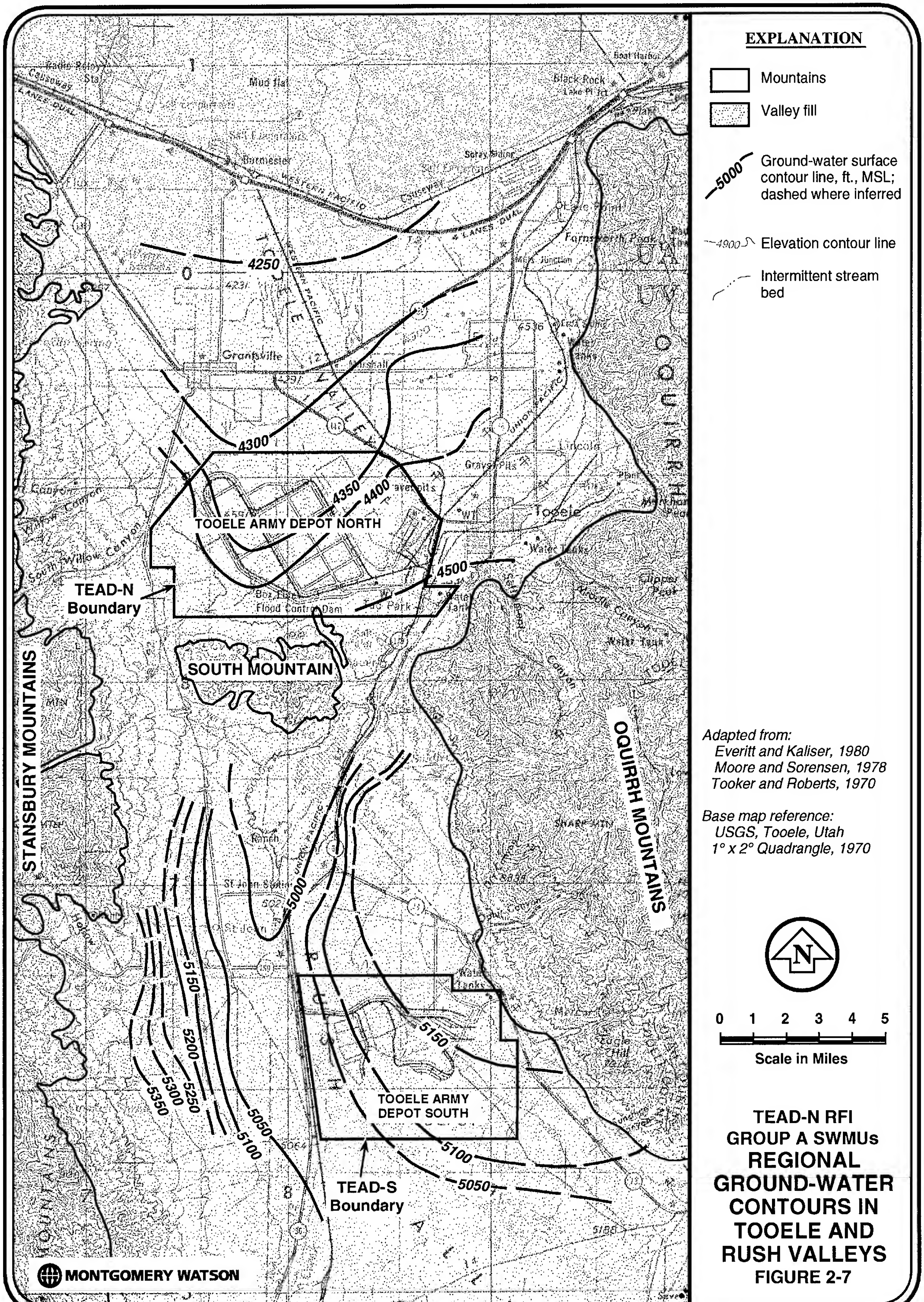
2.5.1.4. Groundwater conditions vary throughout the Tooele Valley; unconfined, confined, and artesian conditions have been encountered. The depth to groundwater ranges from less than 10 feet bgs in northern Tooele Valley (near the Great Salt Lake) to more than 700 feet bgs along the southwestern margin of TEAD-N.

2.5.1.5. Regionally, groundwater originates at recharge areas along the basin margins and moves inward toward the center of the Tooele Valley. Groundwater flows northward toward the Great Salt Lake and ascends to discharge areas in the northern parts of the valley. Recharge zones along the valley margins and upper reaches of the valley are characterized by downward vertical gradients. Major discharge areas exist north of TEAD-N in the Tooele Valley (e.g., Six-Mile Spring and Fishing Creek Spring). Piezometers and monitoring wells installed near the northern TEAD-N boundary revealed upward vertical gradients in that area (JMM, 1988). Figure 2-7 shows the regional groundwater contours in the Tooele and Rush Valleys.

2.5.2 Site Hydrogeology

2.5.2.1. The aquifer system in the TEAD-N area is composed of bedrock overlain by an extensive alluvial aquifer. The bedrock aquifer occurs beneath a relatively small area of TEAD-N, while the remainder of TEAD-N and the Tooele Valley is directly underlain by the alluvial aquifer. While both the alluvial and bedrock aquifers have unique hydraulic characteristics, they readily communicate groundwater and are, therefore, considered to comprise a single aquifer system (JMM, 1988).

2.5.2.2. Alluvial Aquifer. The alluvial aquifer consists of saturated alluvium and lacustrine sediments composed primarily of gravels, with major interbeds of varying amounts of sands, silts, and clays. The alluvial aquifer ranges in thickness from zero at the bedrock block outcrops north of the IWL area to more than 750 feet near the northern boundary of TEAD-N. Although the alluvial aquifer contains alternating discontinuous layers of fine- and coarse-grained sediments, it is considered to be a single aquifer system because no confining layers have been identified from investigations conducted at the southern end of the Tooele Valley. However, the contrast between the hydraulic conductivities of the fine-grained and coarse-grained layers is sufficient to maintain different hydraulic heads between layers beneath the northern area of the Tooele Valley (JMM, 1988).



TEAD-N RFI
GROUP A SWMUs
REGIONAL GROUND-WATER CONTOURS IN TOOELE AND RUSH VALLEYS
FIGURE 2-7

PROJECT NO. 2942.0190

2.5.2.3. Groundwater flow enters TEAD-N from the southeast, south, and southwest and converges beneath the central part of the site. The general direction of groundwater flow beneath TEAD-N is from the south to north. Throughout the southern portion of TEAD-N, groundwater flow patterns are influenced by downward hydraulic gradients. In contrast, at the northern boundary, the vertical gradients are upward, indicating convergence of flow from deeper parts of the aquifer in this area. In general, the potentiometric surface is relatively flat across TEAD-N, with a hydraulic gradient of approximately 0.007 foot per foot (ft/ft). However, in the vicinity of the bedrock block, the hydraulic gradient steepens and the flow pattern is considerably altered.

2.5.2.4. The average horizontal hydraulic conductivity of the alluvial aquifer is approximately 1,500 gallons per day per square foot (gpd/ft ^{2}) or 7.1 x 10^{-2} centimeters per second (cm/s), whereas the average vertical hydraulic conductivity is approximately 225 gpd/ft ^{2} (1.1 x 10^{-2} cm/s). Because of the heterogeneity of the alluvial aquifer, calculated groundwater velocities range from about 4 feet per year (ft/yr) to greater than 9,800 ft/yr. Based on the vertical hydraulic conductivity values, the average calculated vertical groundwater velocity ranges from less than 1 ft/yr to 200 ft/yr (JMM, 1988). The average effective porosity of the alluvial aquifer was estimated to be 25 percent.

2.5.2.5. Bedrock Aquifer. The bedrock aquifer, consisting primarily of low permeability quartzite and limestone, occurs beneath a relatively small area in the eastern portion of TEAD-N. Although permeability of the bedrock is generally low, strong evidence suggests that extensive fracturing in the bedrock allows considerable groundwater flow (JMM, 1988). Highly fractured or weathered bedrock yield the highest hydraulic conductivities, while unfractured bedrock and fractured bedrock with clay-filled, silicified or calcified fractures have the lowest hydraulic conductivities. With the exception of the IWL area, there is little information regarding the bedrock aquifer at TEAD-N. The hydraulic conductivity of the quartzite bedrock is estimated at 2,000 gpd/ft^2. Where the bedrock contains clay-filled fractures, the hydraulic conductivity is estimated to be two gpd/ft^2. The hydraulic gradients in the bedrock block range from 0.02 to 0.09 ft/ft. The horizontal velocity of groundwater in the bedrock block ranges from less than 10 ft/yr to about 5,500 ft/yr. The average porosity of the bedrock is estimated to be 3 percent.

2.5.3. Groundwater Characteristics

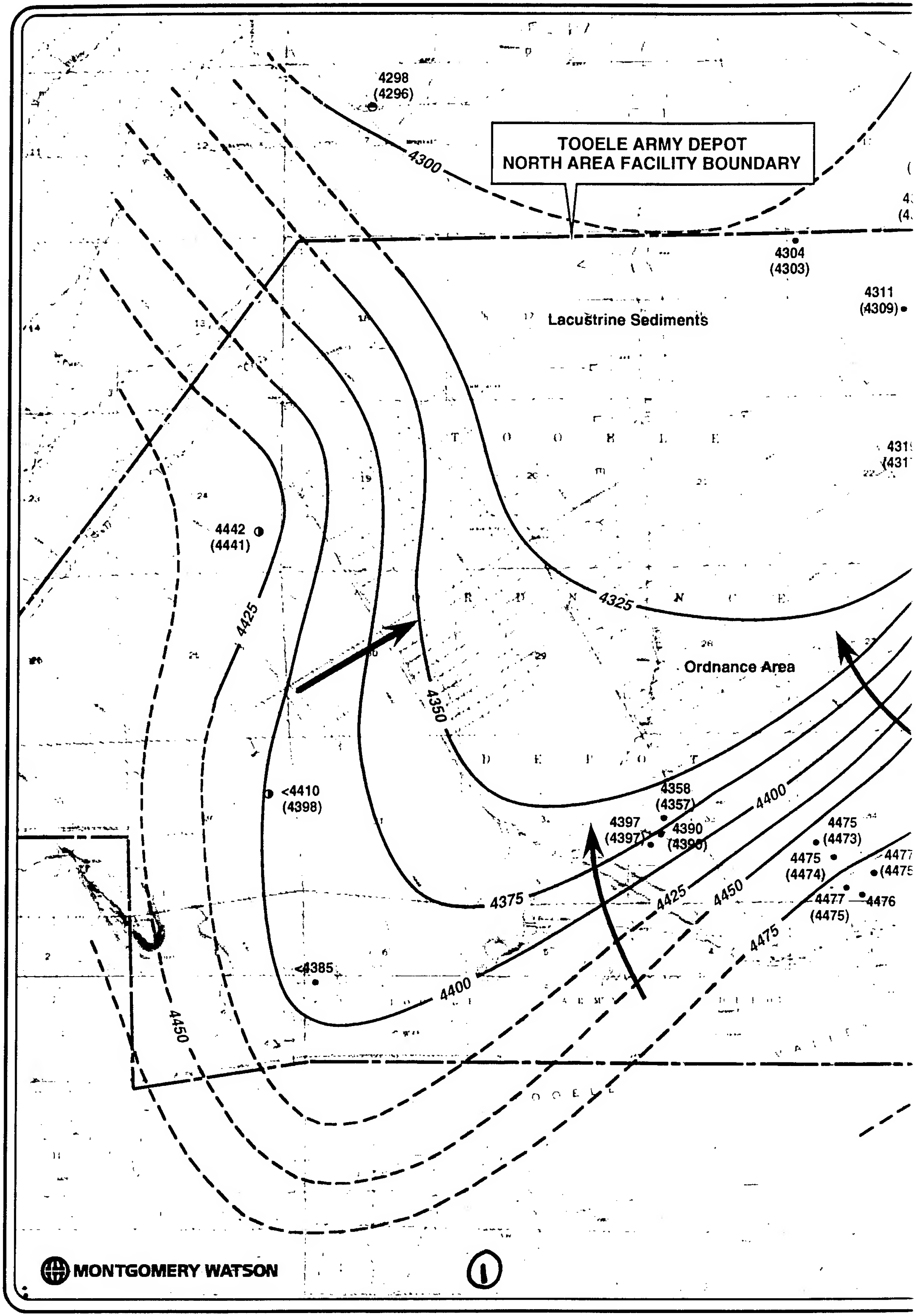
2.5.3.1. Groundwater elevations have been measured at TEAD-N since about 1982. The groundwater surface in the alluvial aquifer is characterized by relatively flat gradients, except in the vicinity of the bedrock block, where gradients steepen considerably. Groundwater elevations in each of the flat areas have been found to vary about ten feet or less. A relatively flat groundwater surface is normally indicative of a uniform hydraulic conductivity within an aquifer. In general, the shape of the alluvial aquifer groundwater surface reflects the paleotopography of the now buried depositional surface. The configuration of the bedrock aquifer indicates that the bedrock block readily transmits groundwater and maintains a very uniform groundwater surface elevation. Historical water level data indicate that water levels rose in response to record high precipitation in Utah between 1982 and 1984 (JMM, 1988). Water levels peaked near the end of 1986 and have gradually declined as precipitation rates have decreased to normal or below normal levels. Hydrographs presented in the *Final Ground-Water Quality Assessment Engineering Report to the Tooele Army Depot, Utah* (JMM, 1988) and water elevation measurements in the *Groundwater Quality Assessment for Tooele Army Depot, Tooele Utah* (ESE, 1991) depict the changes in alluvial and bedrock water table elevations in response to decreased precipitation.

2.5.3.2. Previous investigations also show that localized perched water tables exist beneath two sites (the TNT Washout Facility and Sanitary Landfill) at TEAD-N. In these areas, perched water tables have been shown to vary in depth from approximately 17 to 180 feet bgs. Previous reports indicate that groundwater perched along these zones will eventually reach the regional alluvial aquifer (Weston, 1990).

2.5.3.3. Figure 2-8 shows the groundwater elevation contours generated from the two rounds of groundwater measurements conducted as part of the Phase I RFI at TEAD-N in 1992-93. These measurements were done in June, 1992 and again in January, 1993, during the approximate ground water high and low, respectively. The results show a 1- to 2-foot difference in the groundwater level from seasonal high to seasonal low.

2.5.4. Aquifer Chemistry and Groundwater Use

2.5.4.1. Groundwater Chemistry. Based on extensive water quality analyses, JMM identified three major, naturally occurring groundwater types at TEAD-N (Types 1, 2, and 3), which were differentiated from each other based on the concentrations of major



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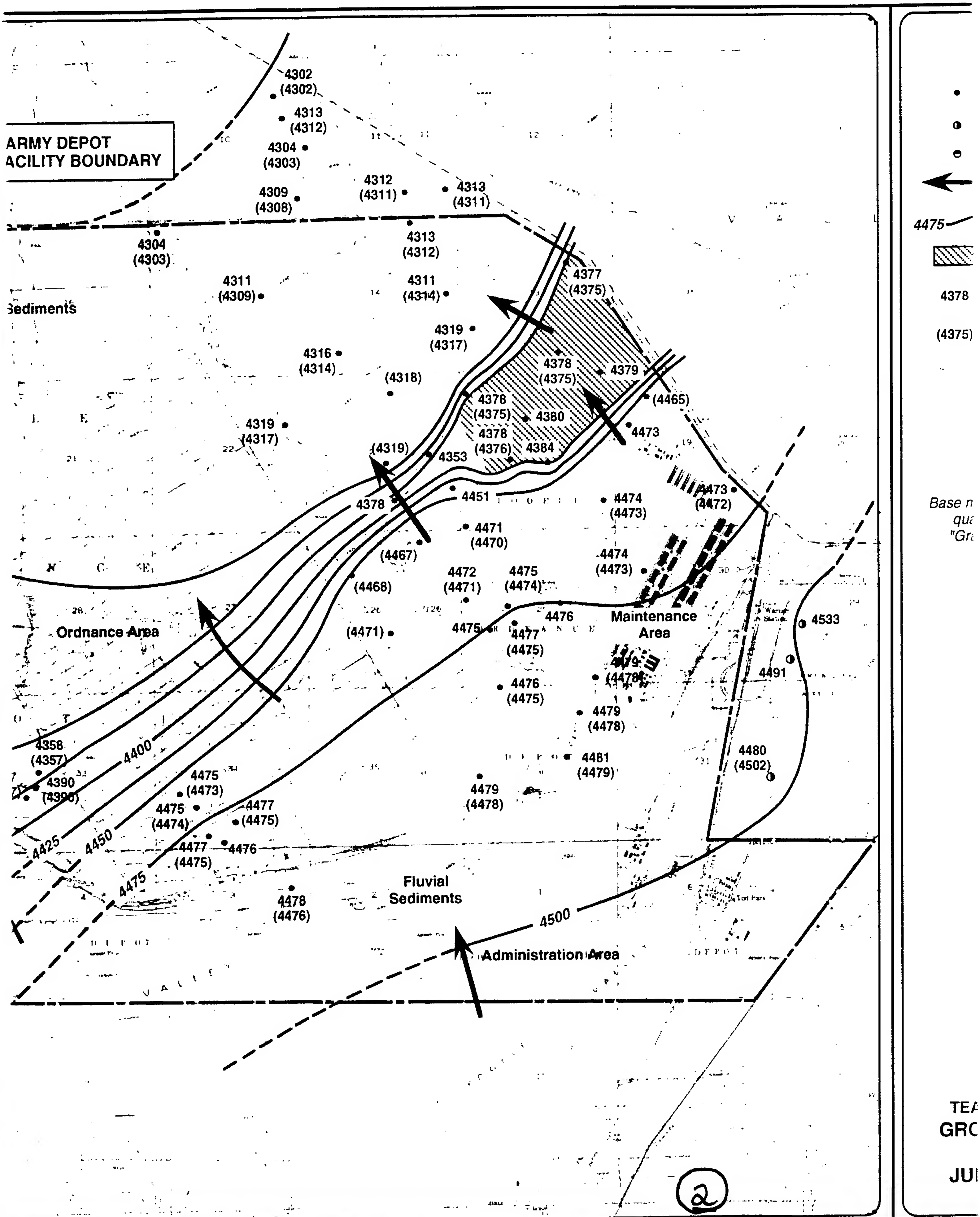
ARMY DEPOT
ACILITY BOUNDARY
3ediments
Ordnance Area
Maintenance Area
Fluvial Sediments
Administration Area
4302 (4302)
4313 (4312)
4304 (4303)
4309 (4308)
4312 (4311)
4313 (4311)
4313 (4312)
4304 (4303)
4311 (4309)
4311 (4314)
4319 (4317)
4316 (4314)
(4318)
4377 (4375)
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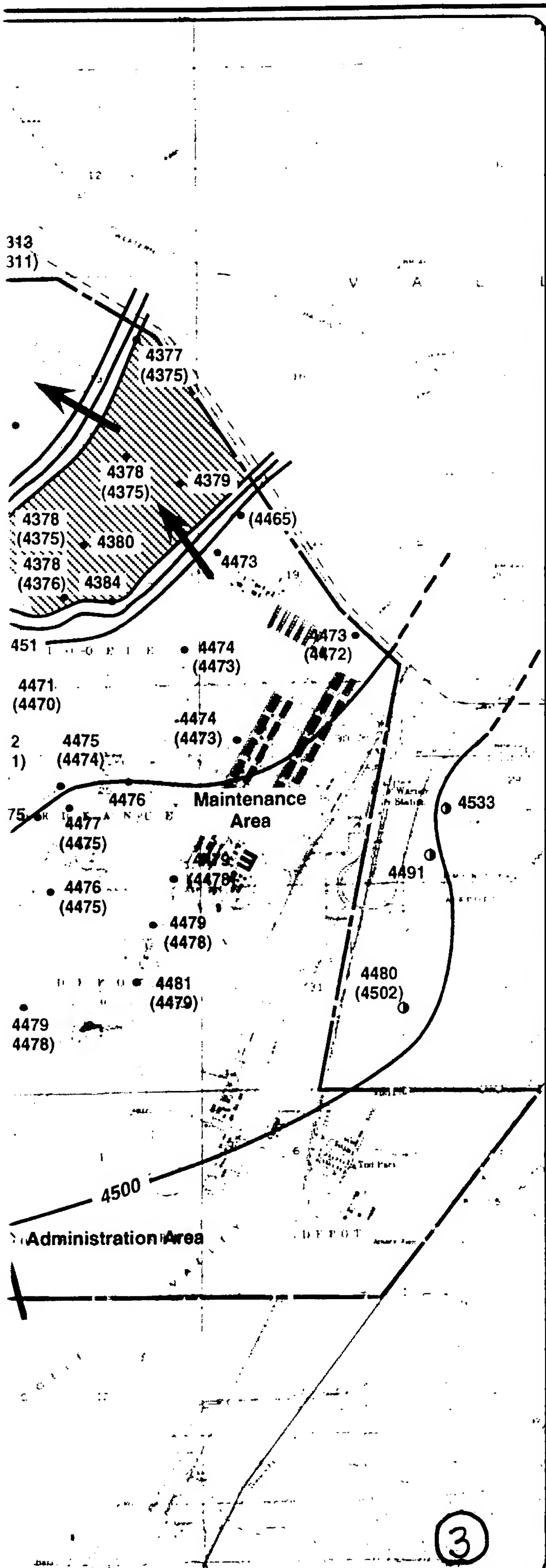


EXPLANATION

- Existing monitoring wells and piezometers
- Municipal and TEAD-N water supply wells
- Private wells
- Interpretive groundwater flow direction
- 4475 — Groundwater elevation contour (feet, MSL) dashed where inferred.
- Area of shallow bedrock aquifer
- 4378 — Groundwater elevation, June 1992 (feet, NGL)
- (4375) — Groundwater elevation, January 1993
- Elevation contour line
- Stream bed

Base map reference: USGS 7.5 minute quadrangles —"Tooele, Utah" and "Grantsville, Utah."

0 4000

Scale in Feet

TEAD-N RFI—GROUP A SWMUs

GROUNDWATER ELEVATION CONTOUR MAP JUNE 1992–JANUARY 1993

FIGURE 2-8

ions (e.g., calcium, magnesium, potassium, sodium, sulfate, chloride, nitrate, fluoride and bicarbonate (JMM, 1988). These three water types are generally found in specific geographic areas across TEAD-N, although overlap occurs.

2.5.4.2. Type 1 groundwater occurs generally within the alluvial and bedrock aquifers on the eastern and western portions of TEAD-N and reflects the influence of recharge waters from the mountains. Type 1 groundwater is characterized as a bicarbonate water (does not contain dominant cations or anions) that is typical of groundwater in recharge areas. In addition, sodium concentrations are lower with respect to chloride compared to other groundwater types.

2.5.4.3. Type 2 groundwater reflects the influence of more saline water from Rush Valley and occurs in the northern, southern, and central portions of TEAD-N. It is characterized by higher concentrations of all major ions, specifically chloride and sodium, than Type 1 groundwater.

2.5.4.4. Type 3 groundwater occurs in the deeper parts of the alluvial aquifer north of the TEAD-N boundary, beneath the off-depot area investigated by JMM (1988). This groundwater has geothermal characteristics and contains the highest concentrations of sodium and chloride, and calcium and sulfate.

2.5.4.5. Groundwater Use. Water supply wells at TEAD-N are used intermittently. Data collected in 1981 indicate that water use at TEAD-N was 325,296,000 gallons. During 1981, domestic water use at TEAD-N accounted for approximately 17 percent of total water usage, and industrial use accounted for the remainder. Approximately 40 percent of total annual discharge from the Tooele Valley groundwater system is to wells, with the remaining discharge attributed to springs, evapotranspiration, and underflow to the Great Salt Lake. Previous reports estimate that TEAD-N usage accounts for only 4 percent of water use within Tooele Valley (JMM, 1988).

2.5.4.6. Several large irrigation and livestock supply wells are located north of TEAD-N. These irrigation and stock wells are pumped in the summer months and may locally affect the groundwater flow beneath TEAD-N during this period (WCC, 1986).

2.6 ECOLOGY

2.6.0.1. The objectives of this section are to identify the plant and animal species that are found in the TEAD-N area and to identify threatened or endangered plant and animal species that may be present at TEAD-N. The following sections discuss the vegetation, wildlife habitats, and animal species found in the TEAD-N area. Some of the information presented in this section was obtained from a Remedial Investigation Report for TEAD-N prepared by Rust (Rust E&I, 1994). Additional information was collected by Montgomery Watson during the Phase II RFI field work.

2.6.1. Vegetation

2.6.1.1. In this section, the major floras present at TEAD-N will be discussed with respect to climate and the soil types in which they grow. Threatened or endangered plant species that occur on TEAD-N, or have the potential to occur on the facility, are also discussed.

2.6.1.2. TEAD-N consists of undeveloped rangeland classified as an *Artemesia* Biome. The plants known to occur in the area consist of native, introduced, and ornamental species (which will not be discussed), with the dominant plant types consisting of sagebrush (Artimisia) and saltbrush (Artiplex). Plant-community development at TEAD-N is a function of precipitation, temperature, and soil type (Welsh and others, 1987). The amount of precipitation available during the growing season is the most important factor determining the species present, the number of individuals, and the general productivity of the vegetation and soils of the area. In addition to adapting to low precipitation and high evaporation rates, plants at TEAD-N have adapted to moderately eroded soils and to alkaline and saline soils. Portions of the region are frequently occupied by saline pans, salt flats, or fresh to saline lakes or ponds (Welsh and others, 1987). Because soil type is a principal controlling factor in plant community development, seven vegetative ranges have been identified at TEAD-N based upon soil types (RUST, 1994). These vegetative range types include:

- Semidesert Sand (Utah Juniper and Wyoming Big Sagebrush) - consist of Berent-type soils

- Semidesert Gravelly Loam (Wyoming Big Sagebrush) - consist of Hiko Peak and Taylors flat complexed soils

- Semidesert Loam (Wyoming Big Sagebrush) - consist of Taylors flat loam and Medburn fine sandy loam

- Semidesert Alkali Loam (Black Greasewood) - consist of Manassa silt loam and Medburn fine sandy loam

- Upland Stony Loam (Utah Juniper) - consist of Abela very gravelly loam

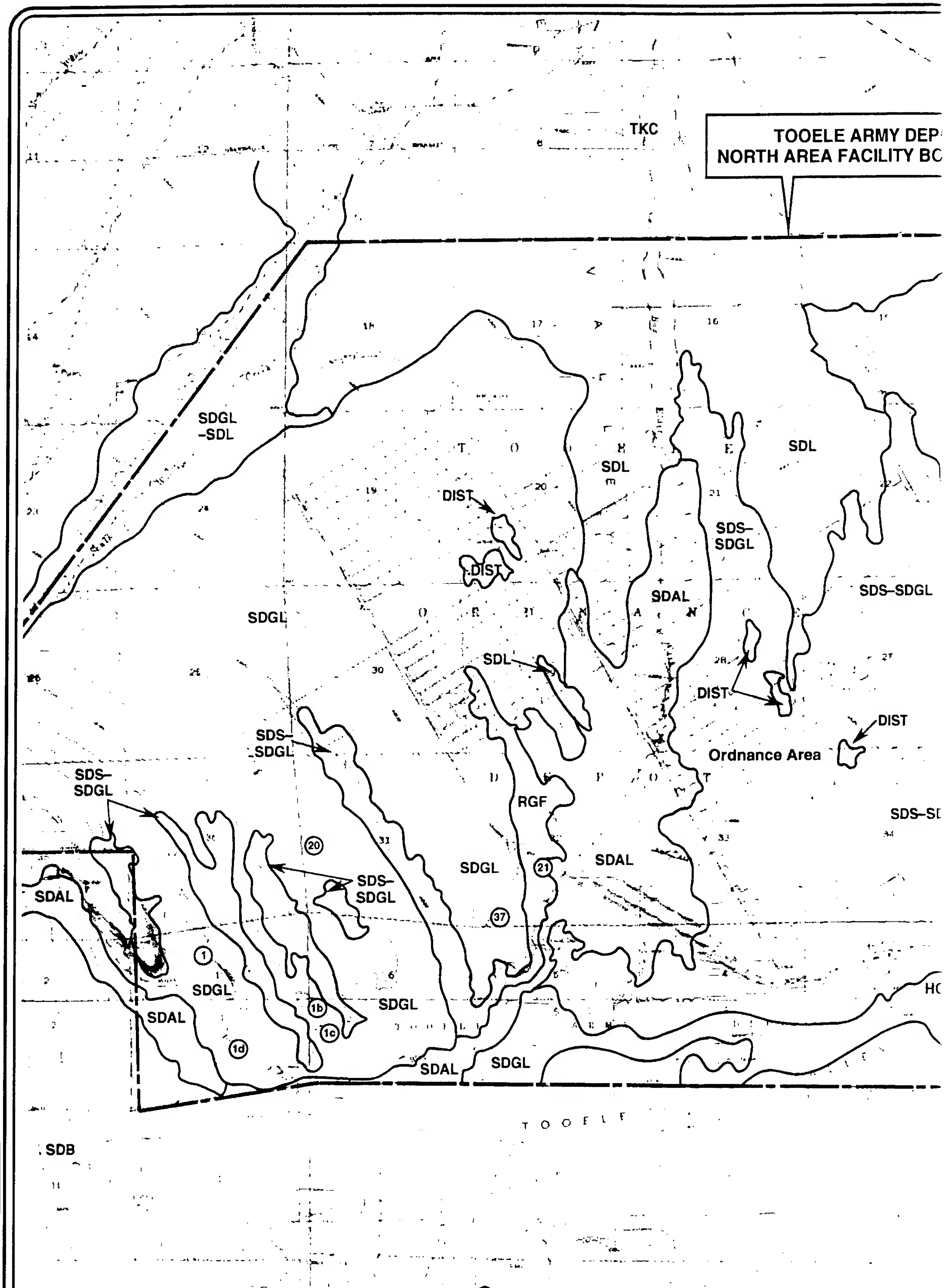
- Loamy Bottom (Basin Wildrye) - consist of Birdow loam

- Upland Loam (Mountain Big Sagebrush) - consist of Doyce loam.

2.6.1.3. Each of the vegetative range types is described in the following paragraphs, which include information about the dominant plant species and soil types where they grow. Figure 2-9 shows the distribution of these vegetative map units at TEAD-N. In addition, Table 2-2 provides a comprehensive list of plant families and species identified at TEAD-N, or that have the potential to occur on the facility. Included in this table are common and scientific plant names. Table 2-2 has been compiled from the Rust investigation (RUST, 1994) and field observations by both Montgomery Watson and Rust personnel.

2.6.1.4. Semidesert Sand. This vegetative range complex occurs on the Berent-type soils. Vegetation identified on these types of soils includes Utah juniper, Wyoming big sagebrush, needle-and-thread grass, and cheatgrass, The potential plant community on this mapping unit is an overstory of Utah juniper with approximately 30 percent cover. Understory vegetation consists of about 45 percent perennial grasses (including Indian ricegrass, fourwing saltbrush, sand dropseed, scarlet globemallow, bud sagebrush, and spiny hopsage), 35 percent shrubs, and 20 percent forbs. Important plant species for human and wildlife use are needle-and-thread grass, Indian ricegrass, and fourwing saltbrush (USSCS, 1991).

2.6.1.5. Semidesert Gravelly Loam. This vegetative range type occurs on the Hiko Peak gravelly loam-type soils. The dominant plant species currently found in these soils include Wyoming big sagebrush, Douglas rabbitbrush, Indian rice grass, and cheatgrass. The potential plant community consist of approximately 45 percent perennial grasses, 20 percent shrubs, and 15 percent forbs. Important plant species for human and wildlife



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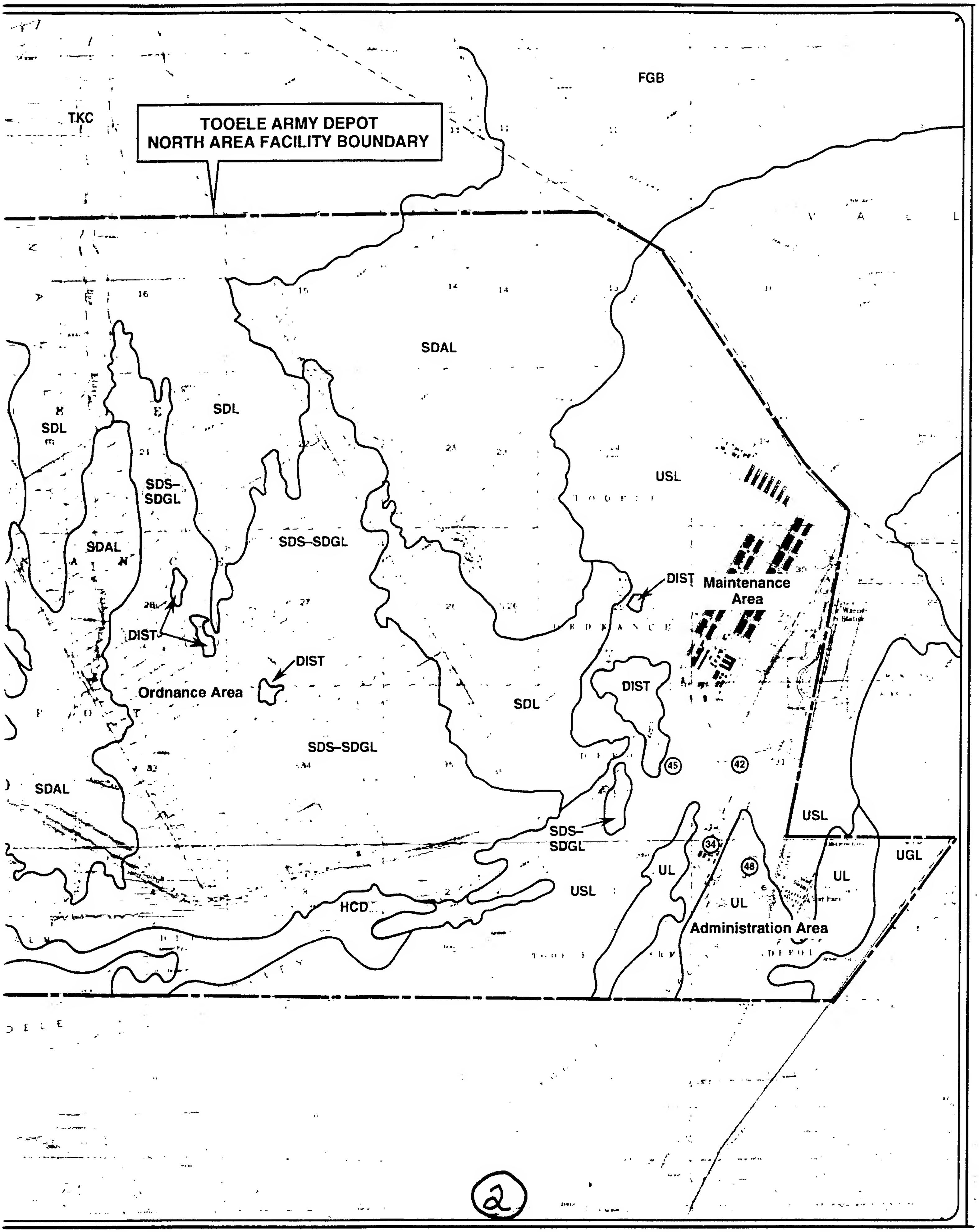
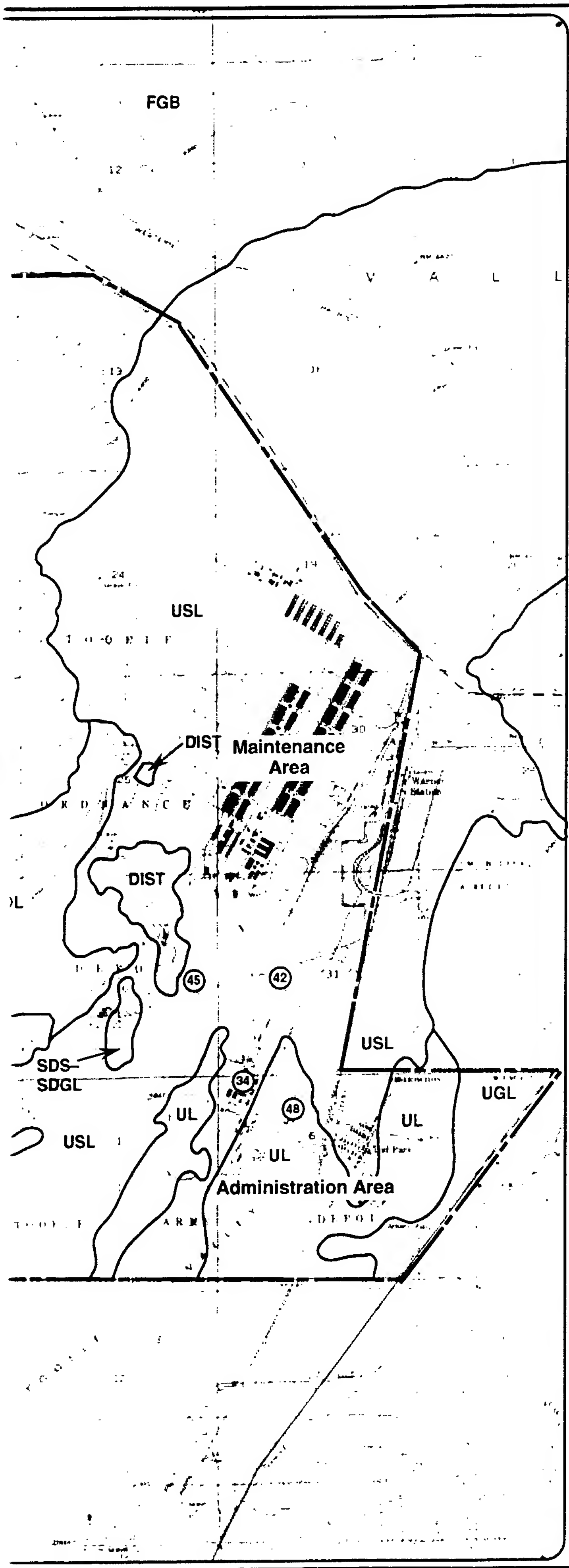


TOOELE ARMY DEPOT
NORTH AREA FACILITY BOUNDARY
TKC
FGB
SDAL
SDL
SDS–SDGL
SDAL
DIST
Ordnance Area
DIST
SDS–SDGL
SDS–SDGL
SDL
USL
DIST
Maintenance Area
DIST
SDAL
SDS–SDGL
HCD
USL
UL
UL
USL
UL
UGL
Administration Area



EXPLANATION

DIST	Disturbed Areas
SDS–SDGL	Semi-Desert (Utah Juniper); Semi-Desert Gravelly Loam (Wyoming Big Sagebrush)
SDGL–SDL	Semi-Desert Gravelly Loam (Wyoming Big Sagebrush);Semi-Desert Loam (Wyoming Big Sagebrush)
SDL	Semi-Desert Loam (Wyoming Big Sagebrush)
SDAL	Semi-Desert Alkali Loam (Black Greasewood)
SDGL	Semi-Desert Gravelly Loam (Wyoming Big Sagebrush)
LB	Loamy Bottom (Basin Wild Rye)
UL	Upland Loam (Mountain Big Sagebrush)
UGL	Upland Gravelly Loam (Mountain Big Sagebrush)
USL	Upland Stoney Loam (Pinon–Utah Juniper)

Elevation contour line

Stream bed

Solid Waste Management Units (SWMUs)

1	Open Burning/Open Detonation Areas
20	AED Deactivation Furnace Site
21	AED Deactivation Furnace Building
34	Pesticide Handling and Storage Area
37	Contaminated Waste Processing Plant
42	Bomb Washout Building
45	Stormwater Discharge Area
48	Old Dispensary Discharge–Building 400

Source: USSCS, 1991

N

0 4000

Scale in Feet

TEAD N RFI—GROUP A SWMUs

VEGETATION MAP

FIGURE 2-9

3

TABLE 2-2

POTENTIAL PLANT SPECIES AT TEAD-N

Latin Name	Common Name	Observed at TEAD-N	
		(RUST, 1994)	(MW, 1993e)
SHRUBS AND SUBSHRUBS			
FAMILY ANACARDIACEAE	SUMAC		
Rhus aromatica	Squaw Berry	X	
FAMILY ACERACEAE	MAPLE		
Acer negundo	Boxelder	X	X
FAMILY ASTERACEAE	COMPOSITE		
Artemisia nova	Black sagebrush	X	
Artemisia spinescens	Bud Sagebrush	X	X
Artemisia tridentata	Wyoming Big Sagebrush	X	X
Chrysothamnus nauseosus	Tall Rabbitbrush	X	X
Chrysothamnus douglasii	Douglas Rabbitbrush		X
Chrysothamnus viscidiflorus	Viscid Rabbitbrush		
Tetradymia glabrata	Littleleaf Horsebrush		
Tetradymia spinosa	Spiny Horsebrush		
FAMILY CAPRIFOLIACEAE	HONEYSUCKLE		
Sambucus caerulea	Blue Elder	X	
FAMILY CHENOPODIACEAE	GOOSEFOOT FAMILY		
Atriplex canesceus	Four-wing Saltbrush	X	X
Atriplex confertifolia	Shadscale		X
Atriplex falcata	Sickle Satlbush	X	
Atriplex gardneri	Gardner Saltbush		
Atriplex rosea	Tumbling Saltweed		
Atriplex tridentata	Trident Saltbush	X	
Sarcobatus vermiculatus	Black Greasewood	X	X
FAMILY ELAEAGNUS	OLEASTER		
Elaeagnus angustifolia	Russian Olive	X	X
FAMILY EPHEDRACEAE	JOINT FIR		
Ephedra viridis	Mormon Tea	X	
FAMILY PINACEAE	PINE		
Juniperus osteosperma	Utah Juniper	X	X
FAMILY ROSACEAE	ROSE		
Coleogyne remosissima	Blackbrush		
Prunus virginiana spp. melanocarpa	Chokecherry		
Purshia mexicana var. stansburiana	Cliff-rose		
Purshia tridentata	Antelope Bitterbrush	X	X
FAMILY SALICACEAE	WILLOW		
Populus sargentii	Plains Cottonwood	X	
Salix exigua	Coyote Willow	X	
FAMILY TAMARICACEAE	TAMARISK		
Tamarix chineusis	Tamarisk	X	
FAMILY ULMACEAE	ELM		
Ulmus pumila	Chinese Elm	X	X
CACTI			
FAMILY CACTACEAE	CACTUS		
Opuutia polyacantha	Plains Prickly Pear	X	
FORBS			
FAMILY AGROSTIDEAE	REDTOP		
Sporobolos cryptandrus	Sand Dropseed	X	

TABLE 2-2

POTENTIAL PLANT SPECIES AT TEAD-N
(CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)
FAMILY ASCLEPIADACEAE	MILKWEED		
Asclepias speciosa	Showy Milkweed	X	
FAMILY ASTERACEAE	COMPOSITE		
Antennaria microphylla	Rosy Pussytoes		
Chaenactis douglasii	Dusty Miller	X	
Chaenactis stevioides	Pincushion		
Cirsium arvense	Canadian Thistle	X	
Cirsium neomexicanum	New Mexican Thistle	X	
Crepis vulgare	Bull Thistle	X	
Crepis acuminata	Tapertip Hawksbeard		
Crepis occidentalis	American Hawksbeard		
Erigeron divergens	Spreading Fleabane	X	
Erigeron engelmannii	Engelmann Daisy	X	
Erigeron flagellaris	Trailing Daisy		
Grindelia squarrosa var. serrulata	Curlycup Gumweed	X	X
Haplopappus acaulis	Stemless Goldenweed		
Helianthus annuus	Common (Annual) Sunflower	X	X
Lactuca serriola	Prickly Wild Lettuce	X	X
Senecio spartoides var. multicapitatus	Broom Groundsel		
Tragopogon dubius ssp. major	Yellow Goatsbeard	X	X
FAMILY BORAGINACEAE	BORAGE		
Cryptantha humilis	Cryptantha	X	
Cryptantha micrantha	Purpleroot	X	
Cynoglossum officinale	Hound's Tongue		
FAMILY CHENOPODIACEAE	GOOSEFOOT		
Allenrolfea spp	Pickleweed		
Chenopodium album	Pigweed	X	
Eurotia lanata	Winterfat	X	
Halogeton glomerata	Halogeton		X
Kochia americana	Green Molly	X	X
Kochia scoparia	Gray Molly (Kochia)	X	X
Salsola iberica	Russian Thistle	X	X
Suaeda occidentalis	Western Seepweed	X	
FAMILY COMPOSITAE	SUNFLOWER		
Arctium minus	Burdock	X	
Balsamorhiza hookeri	Hooker's Balsamroot	X	
Chrysothomnus viscidiflorus	Sticky-flowered Rabbitbrush	X	
Gutierrezia sarothrae	Broom Snakeweed (Matchwood)	X	X
Leucelene ericoides	Heath Aster	X	
Lygodesmia grandiflora	Rush Pink	X	
Machaeranthere canesceus	Hoary Aster	X	
Salvia dorrii	Desert Sage	X	
Tetradymia canesceus	Littleleaf Horsebrush	X	
Tragopogon dubius	Western Yellow Goatsbeard	X	
Xonothocephalum sarothrae	Snakeweed	X	
FAMILY CONVOLVULACEAE	BINDWEED		
Convolvulus arvensis	Creeping-Jenny (Bindweed)	X	X
FAMILY CRUCIFERAE	MUSTARD		
Capsella bursa-pastoris	Shepard's Purse	X	X
Cardaria draba	Whitetop (Peppergrass)	X	
Camelima microcarpa	False Flax	X	
Chorispora tenella	Purple Mustard	X	
Conringia orientalis	Hare's Ear		
Descurainia pinnata	Pinnate Tansymustard	X	
Descurainia sophia	Flixweed Tansymustard	X	X
Erysimum aperum	Wallflower		

TABLE 2-2

POTENTIAL PLANT SPECIES AT TEAD-N
(CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)
FAMILY CRUCIFERAE (continued)			
Hutchinsia procumbens	Slenderweed		
Lepidium densiflorum	Prairie Peppergrass		X
Lepidium montanum	Peppergrass	X	
Lepidium perfoliatum	Clasping Peppergrass	X	X
Lesquerella occidentalis	Western Bladderpod		
Sisymbrium altissimum	Jim Hill Mustard		X
Sisymbrium officiale	Hedge Mustard	X	
Stanleya pinnata	Prince's Plum	X	
Thelypodiopsis vermicularis	Thelypody		
Thelypodiium sagittatum	Arrowleaf Thelypody		
FAMILY EUPHORIBIACEAE	SPURGE		
Euphorbia glyptosperma	Euphorb	X	
FAMILY FABACEAE	PEA		
Astragulus bekwithii	Beckwith Milkvetch		
Astragulus calycosus	Torrey Milkvetch		
Astragalus cibarius	Browse Milkvetch	X	
Astragalus convallarius	Timber Milkvetch		
Astragalus speciosa	Showy Milkvetch		X
Astragalus utahensis	Utah Milkvetch		
Lathyrus brachycalyx	Shortcalyx Peavine		
Lupiunus brevicoulis	Shortstem Lupine	X	
Lupiunus caudatus	Spurred Lupine		
Melilotus alba	White Sweetclover	X	X
Melilotus officinalis	Yellow Sweetclover	X	X
FAMILY GENTIANACEAE	FILAREE		
Erodium cicutarium	Cutleaf Filaree (Storksbill)	X	X
FAMILY LABIATAE	CATNIP		
Marrubium vulgare	White Horehound		X
Nepeta cataria	Catnip		X
FAMILY LEGUMINOCAE	LEGUMES		
Medicago satiua	Alfalfa	X	
FAMILY LILLIACEAE	LILLY		
Allium acuminatum	Pointed Wild Onion	X	
Allium nevadense	Onion	X	
Calochortus nuttallii	Mariposa (Sego Lily)	X	
Zigadeuus paniculatus	Death Camus	X	
FAMILY LOASACEAE	BLAZINGSTAR		
Acrolasia albicaulis	Acrolasia		
Mentzelia albicaulis	Whitestem Blazingstar		
FAMILY MALVACEAE	GLOBEMALLOW		
Sphaeralcea coccinea spp. dissecta	Scarlet Globemallo	X	X
Sphaeralcea grossulariifolia	Gooseberryleaf Globemallow		
FAMILY ONAGRACEAE	EVENING PRIMROSE		
Oenothera caespitosa	Morning Lily		
Oenothera pallida	Evening Primrose		
FAMILY POLEMONIACEAE	PHLOX		
Gilia aggregata	Scarlet Gilia		
Gilia leptomeria	Gilia	X	
Phlox hoodii ssp. canescens	Hood Phlox		X
Phlox longifolia	Longleaf Phlox		X

TABLE 2-2

POTENTIAL PLANT SPECIES AT TEAD-N (CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	Observed at TEAD-N (MW, 1993e)
FAMILY POLYGONACEAE			
Eriogonum ovalifolium var. nevadensis	Wild Buckwheat		
Erigonum unbellatum	Sulfur Buckwheat		
Rumex crispus	Curly Dock	X	
FAMILY RANUNCULACEAE	BUTTERCUP		
Ranunculus testiculatus	Bur Buttercup	X	
FAMILY SCROPHULARIACEAE	FIGWORT		
Castilleja chromosa	Paintbrush	X	
Penstemon linarioides ssp. coloradoensis	Creeping Penstemon		
Verbascum thapsus	Mullein		X
Verbascum vergatum	Wand Mullein		
Veronica biloba	Bilobed Speedwell		
FAMILY TYPHACEAE	CATTAIL		
Typha augustifolia	Narrowleaf Cattail	X	
Typha latifolia	Common Cattail	X	X
FAMILY UMBELLIFERAE	PARSLEY		
Conium maculatum	Poison Hemlock		X
FAMILY VERBENACEAE	VERBENA		
Verbena bracteata	Vervain	X	
GRAMINOIDS			
FAMILY HORDEAE	BARLEY		
Elymus smithii	Smith's Wild Rye	X	
Hordeum jubatum	Wild Barley	X	
FAMILY JUNCACEAE	SEDGE		
Juncus arcticus ssp. vallicola	Arctic Rush		
FAMILY POACEAE (GRAMINEAE)	GRASS		
Agropyron cristatum ssp. desertorum	Crested Wheatgrass	X	X
Agropyron smithii	Western Wheatgrass		X
Agropyron spicatum	Bluebunch Wheatgrass	X	X
Alopecurus pratensis	Meadow Foxtail	X	
Aristida longiseta	Red Three-Awn		X
Aristida purpurea	Three-awn	X	
Bouteloua gracilis	Blue Gramagrass	X	X
Bromus tectorum	Cheatgrass	X	X
Distichlis stricta	Inland Saltgrass		
Elymus cinerus	Basin Wildrye		X
Elymus elongatus	Tall Wheatgrass	X	
Elymus elymoides	Squirreltail	X	
Hilaria jamesii	Galleta Grass		X
Phalaris arundinacea	Reed Canarygrass		X
Phragmites communis	Common Reed		
Poa bulbosa	Bulbous Bluegrass	X	
Poa compressa	Canada Bluegrass		X
Poa fendleriana	Muttongrass		
Poa secunda	Sandberg Bluegrass	X	
Puccinellia spp.	Alkaligrass		
Sitanion hystrix	Bottlebrush Squirreltail		X
Spartina gracilis	Alkali Cordgrass		
Sporobolus airoides	Alkali Sacaton	X	X
Sporobolus cryptandrus	San Dropseed		X
Stipa comata	Needle-and-Threadgrass	X	X
Stipa hymenoides	Indian Ricegrass	X	X

use are Wyoming big sagebrush, bluebunch wheatgrass, Indian ricegrass, bottlebrush squirreltail, Nevada bluegrass, hood phlox, rosy pussytoes, shadscale, and Douglas rabbitbrush (USSCS, 1991).

2.6.1.6. Semidesert Loam. This range type occurs primarily on two soil types at TEAD-N; the Taylors Flat loam and the Medburn fine sandy loam. The dominant plant species in this vegetative range consist of Wyoming big sagebrush, Indian ricegrass, and cheatgrass. The potential plant community on this range site is about 50 percent perennial grasses, 35 percent shrubs, and 15 percent forbs. Important plant species for human and wildlife use are Wyoming big sagebrush, Indian ricegrass, bottlebrush squirreltail, bluebunch wheatgrass, needle-and-thread grass, scarlet globemallow, penstemon, Hood phlox, and Douglas rabbitbrush (USSCS, 1991).

2.6.1.7. Semidesert Alkali Loam. This range occurs mainly on Manassa silt loam and Medburn fine sandy loam saline. The dominant plant species of this vegetative range include Wyoming big sagebrush, bluebunch wheatgrass, cheatgrass and crested wheatgrass. The potential plant community on this range site is about 30 percent perennial grasses, 55 percent shrubs, and 15 percent forbs. Important plant species for human and wildlife use are Wyoming big sagebrush, black greasewood, Indian ricegrass, bottlebrush squirreltail, and bluebunch wheatgrass (USSCS, 1991).

2.6.1.8. Upland Stony Loam. The primary soil type of this range site is Abela very gravelly loam. The dominant plant species found in conjunction with this soil type are mountain big sagebrush, rabbitbrush, snakeweed, yellowbrush, cheatgrass, bluebunch wheatgrass and Utah juniper. The potential plant community on this range site is an overstory of Utah juniper with about 50 percent canopy cover. The understory vegetation is about 45 percent perennial grasses, 40 percent shrubs, and 15 percent forbs. Important plant species for human and wildlife use are mountain big sagebrush, black sagbrush, bluegrass, bluebunch wheatgrass and antelope bitterbrush (USSCS, 1991).

2.6.1.9. Loamy Bottom. This range site occurs on the Doyce loam-type soils. Dominant plant species found in conjunction with this soil type include basin big sagebrush, bluebunch wheatgrass, rabbitbrush, and basin wildrye. The potential plant community consists of about 70 percent perennial grasses, 20 percent shrubs, and 10 percent forbs. Important plant species for human and wildlife use are basin big sagebrush, basin wildrye, western wheat grass, Nevada bluegrass, tapertip hawksbeard, and rubber rabbitbrush (USSCS, 1991).

2.6.1.10. Upland Loam. This range site type occurs on the Doyce loam soil type. Dominant plant species in this range site include mountain big sagebrush, rabbitbrush, bluebunch wheatgrass, and antelope bitterbrush. The plant community is about 60 percent perennial grasses, 30 percent shrubs, and 10 percent forbs. Important plant species for human and wildlife use are mountain big sagebrush, rabbitbrush, bluebunch wheatgrass, antelope bitterbrush, Indian ricegrass, and bluegrass (USSCS, 1991).

2.6.1.11. Threatened and Endangered Plant Species. A total of 81 species and 37 families of plants have been identified within the Depot area. From a gross perspective, the vegetation is relatively uniform within the TEAD-N facility area. Typical sagebrush-grass communities are interspersed with saltbush vegetation communities. The flora at TEAD-N is dominated by Wyoming big sagebrush and/or Pinyon-juniper vegetation, and its associated species. Locally, black greasewood and its associated species and basin wildrye are also important. An endangered species survey for flora that was conducted at the site did not record any observations of endangered or sensitive species. However, the following federally listed species may occur at TEAD-N based on the types of vegetation communities present at TEAD-N or based on sightings in adjacent areas:

- Phacelia argillaces — clay phacelia
- Cryptantha compacta — cryptantha
- Astragalus desereticus — desert milkvetch
- Astragalus lentiginous ssp. pohlii — pohl milkvetch
- Spiranthes diluvialis — Ute lady's tresses
- Hackelia ibapensis — deep creek stickseed
- Sclerocactus pubispinus — basinfishhook cactus

The clay phacelia is the only specie on the endangered list; all of the others are listed as Category II species (RUST E&I, 1994).

2.6.2. Wildlife

2.6.2.1. TEAD-N is inhabited by a variety of animal species including large and small mammals, birds, amphibians, reptiles, and insects. These animal species occur as permanent, temporary or seasonal residents, or on a migratory basis. The vegetative communities and climate in Tooele Valley have affected the available forage and

ecological niches. As a consequence of these environmental factors, many of the animals in the Tooele Valley region specialize as hibernators, estivators, or nocturnal species.

2.6.2.2. A general wildlife survey was conducted at the TEAD-N facility in order to identify wildlife species that are present, including species that may be of special concern because of a threatened or endangered status. A list of potential and observed species at TEAD-N is presented in Table 2-3. This species list was developed from a potential species list for the area (Donohue, 1990) and from observations made during the field investigations. Table 2-3 is collated from multiple sources, i.e., literature searches, field and road reconnaissance, and consultations with the U.S. Fish and Wildlife Service and Bureau of Land Management (RUST 1994), including the following references: Burt and Grossenheider 1980; Peterson, 1990; Stebbins, 1985; and RUST, 1994.

2.6.2.3. Approximately 127 species have been observed at TEAD-N: 58 species of mammals, 63 of birds, and 6 of reptiles. No species of fish were observed or expected at TEAD-N. Three species of amphibians, identified as being potential inhabitants of TEAD-N, were not observed during the field reconnaissance. No attempt has been made to identify insects or members of the microbial community at TEAD-N.

2.6.2.4. Threatened and Endangered Species There are 15 endangered, candidate, or sensitive wildlife species that are known to occur or potentially occur on the TEAD-N facility. Eleven of these species are protected by the Endangered Species Act of 1973, Section 668-668d.

2.6.2.5. Nine endangered, candidate or sensitive bird species have been either identified in the region or observed on the TEAD-N facility. The bald eagle and American peregrine falcon are endangered species; the golden eagle is protected under the Eagle Protection Act; and the ferruginous hawk, Swainson's hawk, western snowy plover, mountain plover, white-faced ibis, and western yellow-billed cuckoo are listed as federal and State candidate endangered species. Two federal candidate mammalian species, the Skull Valley pocket gopher and the spotted bat, may also occur in Tooele Valley and on the TEAD-N facility. In addition to the eleven species just mentioned, four Utah state sensitive species (the mule deer, pronghorn antelope, sage grouse, and chukar) could occur on the Depot, either as permanent or seasonal residents.

TABLE 2-3

POTENTIAL ANIMAL SPECIES AT TEAD-N

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)	Sensitive Species
MAMMALS				
ORDER CHIROPTERA				
FAMILY MOLOSSIDAE	FREETAIL BATS			
Tadirida brasiliensis	Mexican Freetail Bat			
FAMILY SORICIDAE	SHREW			
Sorex cinereus	Masked Shrew			
Sorex merriami	Merriam Shrew	X		
Sorex obscurus	Dusky Shrew	X		
Sorex palustris	Norther (Water Shrew)			
Sorex vagrans	Vagrant Shrew	X		
FAMILY VESPERTILIONIDAE	PLAINNOSE BATS			
Eptericus fuscus	Big Brown Bat	X		
Euderma maculata	Spotted Bat	X		FCC2
Lasionycteris notcivagaus	Silver-haired Bat	X		
Lasiurius cinereus	Hoary Bat	X		
Myotis californicus	California Myotis	X		
Myotis evotis	Long-eared Myotis	X		
Myotis lucifugus	Little Brown Myotis	X		
Myotis subulatus	Small-footed Myotis	X		
Myotis thysanodes	Fringed Myotis	X		
Myotis velifer	Cave Myotis	X		
Myotis volaus	Long-legged Myotis	X		
Pipistrellus hesperus	Western Pipistrel	X		
Plecotus townsendii	Western Big-eared Bat			
ORDER LAGOMORPHA				
FAMILY LEPORIDAE	RABBIT AND HARES			
Lepus americanus	Snowshoe Hare			
Lepus californicus	Black-Tailed Jackrabbit	X	X	
Lepus townsendi	Whitetail Jackrabbit			
Sylvilagus audubonii	Desert Cottontail	X	X	
Sylvilagus Idahoeusis	Pygmy Rabbit			
Sylviliagus nuttallii	Nuttalls Cottontail	X	X	
ORDER RODENTIA				
FAMILY SCIURIDAE	SQUIRRELS			
Ammospermophilus leucurus	Whitetail Antelope Squirrel	X		
Eutamias dorsalis	Cliff Chipmunk	X		
Eutamias minimus	Least Chipmunk	X	X	
Eutamias umbrinus	Uinta Chipmunk	X		
Marmota flaviventris	Yellow-Bellied Marmot			
Citellus lateralis	Golden-Mantled Ground Squirrel	X		
Citellus townsendii	Townsend's Ground Squirrel	X		
Citellus variegatus	Rock Squirrel	X		
Tamiasciurus hudsonicus	Red Squirrel	X		
FAMILY GEOMYIDAE	POCKET GOPHERS			
Thomomys bottae	Valley Pocket Gopher	X	X	
Thomomys talpoides	Northern Pocket Gopher	X		
Thomomys umbrinus robustus	Skull Valley Pocket Gopher			FCC2
FAMILY HETEROMYIDAE	POCKET MICE AND KANGAROO RATS			
Dipodomys microps	Great Basin Kangaroo Rat	X		
Dipodomys ordii	Ord's Kangaroo Rat	X	X	
Microdipodops megacephalus	Dark Kangaroo Mouse	X		
Perognathus longimembris	Little Pocket Mouse	X		
Perognathus formosus	Long-Tailed Pocket Mouse			
Perognathus parvus	Great-Basin Pocket Mouse	X	X	
Peromyscus truei	Pinyon Mouse	X		

FE Federal Endangered Species
FCC2 Federal Candidate Category 2 Species
EP Protected under the Eagle Protection Act
USS Utah State Sensitive Species

TABLE 2-3

POTENTIAL ANIMAL SPECIES AT TEAD-N
(CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)	Sensitive Species
FAMILY CRICETIDAE	NEW WORLD RATS, MICE, AND VOLES			
Clethrionomys gapperi	Boreal Redback Vole	X		
Lagurus curtatus	Sagebrush Vole	X		
Microtus longicaudus	Long-Tailed Vole	X		
Microtus moutanus	Mountain Vole	X		
Microtus pennsylvanicus	Meadow Vole	X		
Neotoma cinerea	Bushy-Tailed Woodrat	X		
Neotoma lepida	Desert Woodrat	X		
Onychomys leucogaster	Northern Grasshopper Mouse	X		
Peromyscus boylei	Brush Mouse	X		
Peromyscus crinitus	Canyon Mouse			
Peromyscus maniculatus	Deer Mouse	X	X	
Peromyscus truei	Pinyon Mouse	X		
Phenacomys intermedius	Mountain Phenacomys	X		
Reithrodontomys megalotis	Western Harvest Mouse	X		
FAMILY OCHOTONIDAE	PIKAS			
Ocbotona princeps	Pika			
FAMILY MURIDAE	OLD WORLD RATS AND MICE			
Mus musculus	House Mouse	X	X	
Rattus norvegicus	Norway Rat			
FAMILY ZAPODIDAE	JUMPING MICE			
Zapus princeps	Western Jumping Mouse	X		
FAMILY ERETHIZONTIDAE	NEW WORLD PORCUPINES			
Erethizon dorsatum	Porcupine	X		
ORDER CARNIVORA				
FAMILY CANIDAE	WOLVES, FOXES, AND THE COYOTE			
Canis latrans	Coyote	X	X	
Vulpes vulpes	Red Fox			
FAMILY PROCYONIDAE	RACCOON, RINGTAIL, AND COATI			
Bassariscus astutus	Ringtail			
FAMILY MUSTELIDAE	WEASELS, SKUNKS, BADGERS, AND OTTERS			
Martes americana	Marten			
Mephitis mephitis	Striped Skunk	X	X	
Mustela erminea	Short Tailed Weasel	X		
Mustela frenata	Long-Tailed Weasel	X		
Mustela vison	Mink			
Spilogale putorius	Spotted Skunk	X		
Taxidea taxus	Badger	X	X	
FAMILY FELIDAE	CATS			
Felis concolor	Mountain Lion			
Felis rufus	Bobcat			
ORDER ARTIODACTYLA				
FAMILY ANTILOCAPRIDAE				
Antilocapra americana	Pronghorn Antelope	X		USS
FAMILY BOVIDAE				
Oreamnos americanus	Mountain Goat			
Ovis canadensis	Bighorn Sheep			

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USS Utah State Sensitive Species

TABLE 2-3

POTENTIAL ANIMAL SPECIES AT TEAD-N
(CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)	Sensitive Species
FAMILY CERVIDAE	DEER			
Cervus canadeusis	Elk			
Odocoileus hemionus	Mule Deer	X	X	USS
AVES				
ORDER APODIFORMES				
FAMILY APODIDAE	SWIFTS			
Aeronautes saxatalis	White-Throated Swift	X		
FAMILY TROCHILIDAE	HUMMINGBIRDS			
Archilochus alexandri	Black-chinned Hummingbird			
Selasphorus platycercus	Broad-Tailed Hummingbird	X		
Selasphorus rufus	Rufous Hummingbird			
ORDER CAPRIMULGIFORMES				
FAMILY CAPRIMULGIDAE	NIGHTJARS			
Chordeiles minor	Common Nighthawk	X		
Phalaenoptilus nuttallii	Common Poorwill			
ORDER CHARADRIIFORMES				
FAMILY CHARADRIIDAE	PLOVERS			
Charadrius alexandrinus	Western Snowy Plover	X		FCC2
Charadrius mountanus	Mountain Plover			FCC2
Charadrius vociferus	Killdeer	X		
FAMILY SCOLOPACIDEA	SANDPIPERS AND PHALAROPES			
Numenius americanus	Long-billed Curlew			
Gallinago y	Common Snipe			
ORDER CICONIFORMES				
FAMILY ARDEIDAE	HERONS AND BITTERNS			
Ardea herodias	Great Blue Heron			
Egretta thula	Snowy Egret			
FAMILY THRESKIORNITHIDAE	IBISES AND SPOONBILLS			
Bataurus leutiginosus	American Bittern			
Nyoticorax nycticopax	Black-Crowned Night Heron			
Plegadis chihi	White-Faced Ibis			FCC2
ORDER COLUMBIFORMES				
FAMILY COLUMBIDAE	PIGEONS			
Zenaida macroura	Mourning Dove	X		
ORDER CUCULIFORMES				
FAMILY CUCULIDAE	CUCKOOS, ROADRUNNERS AND ANIS			
Coccyzus americanus	Yellow-Billed Cuckoo			FCC2
ORDER FALCONIFORMES				
FAMILY ACCIPITRIDAE	HAWKS			
Accipiter cooperii	Cooper's Hawk			
Accipiter gentilis	Northern Gosshawk			
Accipiter striatus	Sharp-Shinned Hawk			
Aquila chrysaetos	Golden Eagle	X	X	EP
Buteo jamaicensis	Red-tailed Hawk	X	X	
Buteo lagopus	Rough-legged Hawk	X		
Buteo regalis	Ferruginous Hawk	X	X	FCC2
Buteo swainsoni	Swainson's Hawk			FCC2
Curcus cyaneus	Marsh Hawk (Northern Harrier)		X	
Haliaeetus leucocephalus	Bald Eagle	X		FE

FE Federal Endangered Species
FCC2 Federal Candidate Category 2 Species
EP Protected under the Eagle Protection Act
USS Utah State Sensitive Species

TABLE 2-3

POTENTIAL ANIMAL SPECIES AT TEAD-N
(CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)	Sensitive Species
FAMILY CATHARTIDAE	VULTURES			
Cathartes aura	Turkey Vulture	X	X	
FAMILY FALCONIDAE	FALCONS			
Falco colunbarius	Merlin			
Falco mexicanus	Prairie Falcon	X	X	FE
Falco peregrinus	Peregrine Falcon	X	X	
Falco sparverius	American Kestrel		X	
ORDER GALLIFOMES				
FAMILY PHASIANIDAE	FOWL-LIKE BIRDS			
Alectoris chukar	Chukar			USS
Dendragapus obscurus	Blue Grouse			
Phasianus colchicus	Ring-Necked Pheasant			
Centrocercus urophasianus	Sage Grouse			USS
Dendragapus obscurus	Blue Grouse			
ORDER PASSERIFORMES				
FAMILY AEGITHALAIDAE	BUSHTITS			
Psaltriparus minimum	Bushtit			
FAMILY ALAUDIDAE	LARKS			
Eremophila alpestris	Horned lark	X	X	
FAMILY BOMBYCILLIDAE	WAXWINGS			
Bombycilla cedrorum	Cedar Waxwing			
Bombycilla garrulus	Bohemian Waxwing			
FAMILY CERTHIDAE	CREEPERS			
Certhia americana	Brown Creeper			
FAMILY CORVIDAE	CROWS			
Aphelocoma coerulescens	Scrub Jay			
Corvus brachyrhynchos	American Crow	X		
Corvus corax	Common Raven	X	X	
Cyanocitta stelleri	Stellar's Jay			
Gymnorhinus cyanocephalus	Pinyon Jay	X	X	
Nucifraga columbiana	Clark's Nutcracker			
Pica nuttalli	Yellow-Billed Magpie			
Pica pica	Black-Billed Magpie	X	X	
FAMILY EMBERIZIDAE	GROSBEAKS AND SPARROWS			
Amphispiza belli	Sage Sparrow			
Amphispiza bilineata	Black-Throated Sparrow			
Chondestes grammacus	Lark Sparrow			
Junco hyemalis caniceps	Gray-Headed Junco			
Junco hyemalis oreganus	Oregon Junco			
Melospiza lincolnii	Lincoln's Sparrow			
Melospiza melodia	Song Sparrow			
Passerculus sandwichensis	Savannah Sparrow	X		
Passerina amoena	Lazuli Bunting	X		
Pheucticus melanocephalus	Black-headed Grosbeak	X		
Pipilo chlorurus	Green-Tailed Towhee	X		
Pipilo erythrophthalmus	Rufous-Sided Towhee			
Pooecetes gramineus	Vesper Sparrow	X		
Spinus tristis	American Goldfinch			

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TABLE 2-3

POTENTIAL ANIMAL SPECIES AT TEAD-N
(CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)	Sensitive Species
FAMILY EMBERIZIDAE (con't)	GROSBEAKS AND SPARROWS			
Junco hyemalis	Dark-Eyed Junco	X		
Spizella arborea	American Tree Sparrow			
Spizella breweri	Brewer's Sparrow			
Spizella passerina	Chipping Sparrow	X		
Zonotrichia leucophrys	White-Crowned Sparrow			
FAMILY FRINGILLIDAE	FINCHES			
Leucosticte arcloa	Rosy Finch			
Carpodacus cassinii	Cassin's Finch			
Carpodacus mexicanus	House Finch	X		
Loxia curvirostra	Red Crossbill			
Coccothraustes vespertina	Evening Grosbeak			
Carduelis fristis	American Goldfinch			
Carduelis pinus	Pine Siskin	X		
FAMILY HIRUNDINIDAE	SWALLOWS			
Hirundo pyrrhonata	Cliff Swallow			
Hirundo rustica	Barn Swallow	X		
Stelgidopteryx serripennis	Northern Rough-Winged Swallow	X		
Tachycineta bicolor	Tree Swallow			
Tachycineta thalassina	Violet-Green Swallow			
FAMILY ICTERIDAE	ORIOLES			
Agelaius phoeniceus	Red-Winged Blackbird	X		
Euphagus cyanocephalus	Brewer's Blackbird	X		
Molothrus ater	Brown-Headed Cowbird	X	X	
Sturnella neglecta	Western Meadowlark	X	X	
Xanthocephalus xanthocephalus	Yellow-Headed Blackbird	X		
FAMILY LANIIDAE	SHRIKES			
Lanius excubitor	Northern Shrike			
Lanius ludovicianus	Loggerhead Shrike	X		
FAMILY MIMIDAE	MOCKINGBIRDS AND THRASHES			
Mimus polyglottos	Northern Mockingbird			
Oreoscoptes montanus	Sage Thrasher			
FAMILY MUSCICAPIDAE	THRUSHES, SOLITAIRES, BLUEBIRDS, KINGLETS, AND GNATCATCHERS			
Turdus migratorius	American Robin	X		
FAMILY PARIDAE	CHICKADEES AND TITMICE			
Catharus guttatus	Hermit Thrush			
Myadestes townsendi	Townsend Solitaire			
Parus atricapillus	Black-Capped Chickadee	X		
Parus gambeli	Mountain Chickadee			
Polioptila caerulea	Blue-Gray Gnatcatchers			
Regulus calendula	Ruby-Crowned Kinglet	X		
Regulus satrapa	Golden-Crowned Kinglet	X		
Sialia currucoides	Mountain Bluebird	X	X	
FAMILY PARULIDAE	WOOD WARBLER			
Dendroica caerulescens	Black-Throated Warbler			
Dendroica coronata	Yellow-Rumped Warbler	X		
Dendroica petechia	Yellow Warbler	X		
Geothlypis trichas	Common Yellowthroat	X		

FE Federal Endangered Species
FCC2 Federal Candidate Category 2 Species
EP Protected under the Eagle Protection Act
USS Utah State Sensitive Species

TABLE 2-3

POTENTIAL ANIMAL SPECIES AT TEAD-N
(CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)	Sensitive Species
FAMILY PARULIDAE (continued)				
Icteria vireus	Yellow-Breasted Chat	X		
Oporornis tolmiei	Mac Gillivrays Warbler	X		
Vermivora celata	Orange-Crowned Warbler			
Vermivora virginiae	Virginia Warbler			
FAMILY PASSERIDAE	WEAVER FINCHES			
Passer domesticus	House Sparrow	X		
FAMILY SITTIDAE	NUTHATCHES			
Sitta canadensis	Red-Breasted Nuthatch			
Sitta carolinensis	White-Breasted Nuthatch			
FAMILY STURNIDAE	STARLINGS			
Sturnus vulgaris	European Starling	X		
FAMILY SYLVIIDAE	OLD WORLD WARBLERS			
Regulus satrapa	Golden-Crowned Kinglet			
FAMILY THRAUPIDAE	TANAGERS			
Piranga ludoviciana	Western Tanager			
FAMILY TROGLODYTIDAE	WRENS			
Catherpes mexicanus	Canyon Wren			
Cistothorus palustris	Marsh Wren			
Salpinctes obsoletus	Rock Wren	X		
Troglodytes aedon	House Wren	X		
Troglodytes troglodytes	Winter Wren			
FAMILY TYRANNIDAE	TYRANT FLYCATCHERS			
Contopus borealis	Olive-sided Flycatcher			
Contopus sordidulus	Western Wood-Pewee	X		
Empidonax hammondii	Hammond Flycatcher			
Empidonax oberholseri	Dusky Flycatcher			
Empidonax occidentalis	Western Flycatcher	X		
Myiarchus cinerascens	Ash-Throated Flycatcher			
Syaornis saya	Say's Phoebe	X		
Tyrannus verticalis	Western Kingbird	X	X	
FAMILY VIREONIDAE	VIREOS			
Vireo gilvus	Warbling Vireo	X		
Vireo solitarius	Solitary Vireo			
ORDER PICIFORMES				
FAMILY PICIDAE	WOODPECKERS			
Colaptes auratus	Northern Flicker	X		
Colaptes auratus	Red-Shafted Flicker			
Picoides pubesceus	Downy Woodpecker	X		
Picoides willosus	Hairy Woodpecker	X		
Sphyrapicus nuchalis	Red-Naped Sapsucker			
ORDER STRIGIFORMES				
FAMILY STRIGIDAE	OWLS			
Asio flammeus	Short-Eared Owl	X		
Asio otus	Long-Eared Owl	X		
Bubo virginianus	Great Horned Owl	X		
Athene cunicularia	Burrowing Owl	X		
Otus kennicotti	Western Screech-Owl			
Tyto alba	Barn Owl	X		

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TABLE 2-3

POTENTIAL ANIMAL SPECIES AT TEAD-N
(CONTINUED)

Latin Name	Common Name	Observed at TEAD-N (RUST, 1994)	(MW, 1993e)	Sensitive Species
REPTILIA				
ORDER SQUAMATA				
SUBORDER LACERTILIA	LIZARDS			
FAMILY IGUANIDAE	IGUANID			
Cryptophytus collaris	Collared Lizard	X		
Gambelia wislizenii	Long-nosed Leopard Lizard			
Sceloporus graciosus	Sagebrush Lizard			
Uta stansburiana	Side-Blotched Lizard	X	X	
Phrynosoma platyrhinos	Desert Horned Lizard		X	
FAMILY SCINCIDAE				
Eumeces skiltonianus	Great Basin Skink	X		
FAMILY TEIIDAE	WHIPTAILS AND RACE-RUNNERS			
Cnemidophorus tigris	Western Whiptail	X		
SUBORDER SERPENTES	SNAKES			
FAMILY COLUBRIDAE	COLUBRID SNAKE FAMILY			
Coluber coustrictor	Western Yellow-bellied Racer			
Hypsiglena torquata	Night Snake			
Masticophis taeniatus	Striped Whipsnake			
Pituophis melanoleucus deserticola	Great Basin Gopher Snake	X		
Thamnophis elegans	Wandering Garter Snake			
FAMILY VIPERIDAE	PIT VIPERS			
Crotalus viridis lotusus	Great Basin Rattlesnake	X	X	
AMPHIBIA				
ORDER ANURA				
FAMILY BUFONIDAE	TRUE TOADS			
Bufo woodhousei	Western Woodhouse Toad			
FAMILY PELOBATIDAE	SPADEFOOT TOADS			
Scaphiopus intermentanus	Great Basin Spadefoot			
FAMILY RANIDAE	TRUE FROGS			
Rana pipiens	Northern Leopard Frog			

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2.7 DEMOGRAPHY/LAND USE

2.7.0.1. Tooele Valley is predominantly undeveloped, with the exceptions of the cities of Grantsville (1991 population 4,500), and Tooele (1991 population 13,887) and scattered residential developments north of Tooele City. In 1991, the population of Tooele County was 26,601 (Tooele, 1991) Grantsville is approximately 2 miles north of the northwest corner of TEAD-N, while Tooele is adjacent to the northeast corner of the Depot. Livestock grazing and limited cultivation predominate in the valley.

2.7.0.2. Except for the City of Tooele, properties immediately adjacent to TEAD-N boundaries are undeveloped. Properties to the north are used for pasture or cultivation; properties to the west and south are used for rangeland grazing. Properties east of TEAD-N consist of a combination of residential portions of Tooele and undeveloped rangeland along the lower western slopes of the Oquirrh Mountains. A gravel pit and a landfill are also located southeast of TEAD-N along SR 36. Except for the southeastern portion (bounded by SR 36), TEAD-N is bounded on the east by the Union Pacific Railroad right-of-way. The Tooele Municipal Airport and scattered residential homes are located along the eastern boundary north to SR 112, which forms the northeastern boundary of TEAD-N. The area northeast of SR 112 is undeveloped except for a construction company and the Tooele County Landfill.

3.0 PREVIOUS ENVIRONMENTAL INVESTIGATIONS AND RFI METHODOLOGY

3.0.0.1. Previous environmental investigations at TEAD-N were conducted by both government agencies and private contractors, and varied widely in scope, ranging from general surveys of the area to remedial investigations and risk assessments. Although many of the investigations discussed in this section were conducted prior to the designation of various sites as SWMUs, a parenthetical SWMU reference is added to the discussions for clarity, where applicable.

3.0.0.2. Section 3.0 consists of two subsections. The first subsection (Section 3.1) summarizes the previous environmental investigations conducted at TEAD-N that have provided background information related to this RFI. The second subsection (Section 3.2) describes the RFI methodology used to complete this investigation. Section 3.2 contains detailed descriptions of the activities conducted by Montgomery Watson at TEAD-N from 1992 through 1994 in support of this program. This section includes: a summary of the Phase I RFI activities and results; an overview of the Phase II RFI methodologies for field investigation, risk assessment, and evaluations of contaminant fate and transport; and a discussion of the criteria for recommendations for future actions. The risk assessments were performed in accordance with R315-101 of Utah's Administrative Code.

3.1 PREVIOUS INVESTIGATIONS AT TEAD-N

3.1.1. Installation Assessment—1979

3.1.1.1. Both TEAD-N and TEAD-S were investigated in 1979 by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA; currently USAEC) with the objective of assessing environmental quality at TEAD with regard to use, storage, treatment, and disposal of hazardous materials (USATHAMA, 1979). This assessment consisted of a review of existing records and interviews with past and present facility personnel. No environmental sampling was conducted.

3.1.1.2. The assessment concluded that a potential for contaminant migration existed at both TEAD-N and TEAD-S, and indicated that chemical agents, plating rinse waters, and explosives residues were chemicals of potential concern.

3.1.2. Installation Environmental Assessment—1982

3.1.2.1. This assessment was prepared for the Army by its contractor to provide a summary of TEAD activities and facilities thought to have a potential environmental impact (Inland Pacific Engineering Company, 1982). This report described TEAD activities, facilities, and the surrounding environment; and included an inventory of indigenous flora and fauna. Resources were examined in and around the TEAD facility, and the potential impact of facility closure on those resources was examined.

3.1.3. Investigation at the Open Burning/Open Detonation Area—1982-85

3.1.3.1. The TEAD-N Open Burning/Open Detonation (OB/OD) Areas (SWMUs 1, 1a, 1b, 1c) were the subject of a four-phase investigation by the U.S. Army Environmental Hygiene Agency (AEHA) from 1981 through 1984. This investigation evaluated the potential for environmental contamination at OB/OD areas at army depots nationwide, with the overall objective of determining which areas should continue to be used for OB/OD operations.

3.1.3.2. Records reviews and limited sampling of potential source media were conducted. The following summarize the various phases of the investigation with respect to the OB/OD area at TEAD-N:

- Phase I of the investigation was an initial screening to determine which OB/OD facilities warranted sampling and analysis (AEHA, 1982). AEHA identified several areas where detonation, disposal, and burning activities had been conducted previously at the TEAD-N OB/OD Areas.

- Phase II consisted of sampling and analyzing surface and near-surface soil for Extraction Procedure Toxicity (EP Toxicity) of metals and selected explosives (AEHA, 1983). Four previously used detonation pits at the Main Demolition Area were sampled, with six soil samples collected from the area of each pit (24 total). Leachable concentrations of cadmium exceeded the RCRA limit of 1.0 mg/L in all four pits sampled. Several explosives were also detected. Four surface soil samples were collected from the Cluster Bomb Detonation Area (SWMU 1a), and low concentrations of leachable metals and explosives were measured; none above RCRA levels. A total of 14 samples were collected from seven locations at the Burn Pad (SWMU 1b), and had no

leachable analytes above RCRA EP Toxicity limits. In addition, one burn residue sample and two soil samples were collected and analyzed from the Trash Burn Pits (SWMU 1c). Arsenic, barium, mercury, and 2,4,6-TNT were detected.

- Phase III summarized and compared results from all OB/OD areas sampled during Phase II (AEHA, 1984).

- Phase IV consisted of additional sampling and analysis of soils at selected locations, including the Trash Burn Pits (SWMU 1c; AEHA, 1985). Eight surface soil samples and 29 borehole samples were collected between 5 and 20 feet bgs at the Trash Burn Pits during the Phase IV sampling. These samples were analyzed for silver, arsenic, barium, chromium, cadmium, lead, selenium, and mercury on a total and EP Toxicity basis. Six explosive compounds were also analyzed. All EP Toxicity results were below the detection limits, and explosive concentrations did not exceed the 1,000 mg/kg guidelines established by AEHA.

3.1.3.3. The AEHA investigations concluded that lead, cadmium, and barium are metals of concern, but that no remedial action was necessary. AEHA did recommend a hydrogeological evaluation to assess the public health risk of certain explosive compounds in groundwater. No OB/OD areas were closed as a result of this study.

3.1.4. Exploratory Environmental Contamination Survey—1982

3.1.4.1. During 1981-82, the Earth Technology Corporation (ERTEC) conducted an environmental study to identify potential source areas for contamination at both the south and north areas of TEAD (ERTEC, 1982). The study consisted of two phases: Phase I (1981) consisted of a data search and preliminary site visits to identify sites with the greatest potential for surface and subsurface contaminant migration, while Phase II (1982) involved soil, sediment, surface water, and groundwater sampling and analysis. Magnetics, gravity, seismic refraction, and resistivity geophysical techniques were used at TEAD-N to define subsurface features. The program included drilling 10 wells and borings at various locations around TEAD-N.

3.1.4.2. The Phase II investigation concluded that contamination and contaminant migration at TEAD were generally minimal, but that a plume of groundwater

contamination was associated with the Industrial Waste Lagoon (SWMU 2), and possibly other maintenance area facilities. This plume was found to be migrating toward the TEAD-N north boundary, and was noted as a possible long-term source of contamination to the alluvial aquifer. The TNT Washout Ponds were also found to have released RDX to groundwater in the regional aquifer, but the contaminant migration rate was reported to be slow. Recommendations included expanding the groundwater monitoring program, with additional wells and soil borings near the sewage lagoons, and some additional soil sampling.

3.1.5. Analysis of Existing Facilities/Environmental Assessment Report—1983

3.1.5.1. In early 1983, TEAD Facilities Engineering conducted a study to identify and summarize activities and missions associated with TEAD, and perform an environmental assessment of these activities (TEAD Facilities Engineering, 1983). The report described major activities, cultural elements, and environmental characteristics of the TEAD facility.

3.1.5.2. No conclusions or recommendations for additional work were included in this report.

3.1.6. Monitoring Activity and Waste Disposal Review and Evaluation—1985

3.1.6.1. The objective of this review was to determine the adequacy of ERTEC's 1982 Phase I and II investigations, and determine if adequate information was available to support a feasibility study (FS; CH2M Hill, 1985). All available data were reviewed to identify data gaps.

3.1.6.2. CH2M Hill determined that there were data deficiencies in the ERTEC Phase II report, and that geologic, chemical, and hydrologic conditions throughout TEAD should be evaluated. A semiannual sampling of all monitoring and water supply wells was recommended, as well as installation of two additional monitoring wells north of the TNT Washout Facility (SWMU 10).

3.1.7. Study of Environmental Balance—1985

3.1.7.1. Published in March of 1985, this study was conducted by the U.S. Army and described the environmental management program at TEAD (Department of Army,

1985). It developed an ecological profile of the facility, and set goals for TEAD with respect to air, water, solid waste, radiation, and hazardous materials management.

3.1.7.2. The study concluded that further environmental controls were necessary at TEAD to prevent contamination releases.

3.1.8. Performance of Remedial Response Activities, Final Plan—1985

3.1.8.1. In March of 1985, Camp, Dresser, and McKee (CDM) completed a review of Department of Defense documents, with the objective of evaluating the completeness of the documents (CDM, 1985). Technical support and potential approaches to site remediation were discussed.

3.1.8.2. This study was developed as a guide to implementing alternative remedial actions at TEAD.

3.1.9. Analytical/Environmental Assessment Report—1985

3.1.9.1. In November 1985, TEAD Facilities Engineering summarized the conclusions of previous environmental studies at TEAD to assess the potential impacts of projected development at the facility (TEAD-N Facilities Engineering, 1985). Site maps were reviewed, and existing land use studied to update the established Preservation Plan. Interviews were conducted with security, traffic control, and health services personnel.

3.1.9.2. Conclusions from this report stated that no proposed building or project at TEAD would have any long-term or irreversible negative impacts on the environment of the Tooele Valley.

3.1.10. Groundwater Quality Assessment, Tooele Army Depot—1986

3.1.10.1. Between January 1985 and February 1986, Woodward-Clyde Consultants conducted a two-phase field program at TEAD-N, which focused on the groundwater contamination associated with the IWL (SWMU 2) and the connected unlined outfall ditches (WCC, 1986). The lagoon liquid, sludge, and soil surrounding the lagoons and ditches, as well as groundwater from existing monitoring and water supply wells, were sampled and analyzed during Phase I. During the Phase II work, an eight-well detection monitoring system was installed, with wells placed upgradient and downgradient of the

IWL and ditches. Hydraulic conductivity tests and groundwater sampling activities were performed on the eight new wells. Nine existing wells were also sampled.

3.1.10.2. This project reached the following conclusions:

- Regional groundwater flow in the upper portion of the aquifer system is generally to the northwest, and there are two aquifers (alluvial and bedrock) that appeared to be hydraulically connected. Both aquifers were found to have high hydraulic conductivities.

- Leakage from the IWL and unlined ditches had altered local groundwater flow patterns, and created a groundwater mound.

- Groundwater in the vicinity of the IWL and ditches contained concentrations of volatile organic compounds (VOCs), in the range of 1 to 100 micrograms per liter (µg/L). The extent of the contamination, especially to the north and west, was not defined.

- Contaminated media included the industrial waste water and sludge in the IWL.

- Contaminants of concern included VOCs, semi-volatile organic compounds (SVOCs), and metals.

3.1.11. Engineering Report for Closure of the Industrial Wastewater Lagoon—1986

3.1.11.1. In March of 1986, James M. Montgomery (now Montgomery Watson) completed an engineering report that assessed feasible alternatives for the closure of the IWL with respect to cost, effectiveness, and regulatory compliance (JMM, 1986). The necessary engineering analyses for closure were developed. This report described the distribution of source chemicals and discussed available treatment processes.

3.1.11.2. The report concluded that for source soil and sludge at the IWL, removal and off-site disposal, or removal to a new, on-site disposal facility were the most feasible remedial alternatives.

3.1.12. Industrial Wastewater Lagoon and Ditches-Groundwater Quality Assessment Report, Corrective Action Plan, and Record of Decision—1986

3.1.12.1. This three-phase investigation was conducted by James M. Montgomery to define the extent and magnitude of the groundwater contamination associated with the Industrial Waste Lagoon (SWMU 2) and wastewater outfall ditches (JMM, 1986).

- Phase I characterized the geologic conditions and groundwater flow in the area using 31 piezometers.
- Phase II determined the distribution of chemicals in the groundwater using 25 groundwater monitoring wells.
- Phase III evaluated potential remedial alternatives, and included additional monitoring well installation and sampling.

3.1.12.2. The report concluded that trichloroethylene (TCE) was the predominant contaminant, and that TCE was present in the highest concentrations beneath the wastewater ditches south of the IWL. A remedial strategy using extraction wells, an air stripper, and injection wells at the northern end of TEAD-N was developed. The time required for remediation was estimated to be 30 years, and the need for additional monitoring wells to further characterize groundwater quality was noted.

3.1.13. EPIC Aerial Photography Report—1986

3.1.13.1. Through an interagency agreement between the EPA and USATHAMA, the Environmental Photographic Interpretation Center (EPIC) provided imagery analysis support for a study of selected sites at both TEAD-N and TEAD-S (USEPA and EPIC, 1986). Archival black and white and color infrared photographs were obtained from existing imagery libraries of the U.S. Geological Survey (USGS), the EPA, and the Agricultural Stabilization and Conservation Service (ASCS). These photographs were used to identify possible areas of past use, storage, treatment, and disposal of hazardous materials.

3.1.13.2. The focus of the report at TEAD-N was the OB/OD Area (SWMU 1) (previously referred to as the "Demolition Range") and the TNT Washout Facility

(SWMU 10). Eight photographs taken from 1952 to 1981 were provided of the areas presently occupied by SWMUs 1, 1a, 1b, 1c, and 1d.

3.1.13.3. The report enumerated visible activities at the areas of interest over the covered period.

3.1.14. Interim RCRA Facility Assessment—1987

3.1.14.1. A facility assessment was performed by NUS Corporation to evaluate releases of hazardous wastes and to identify corrective actions, where necessary, under the Hazardous and Solid Waste Amendments (HSWA) of 1984 (NUS, 1987). Existing information from EPA and State of Utah files was compiled and reviewed to verify characteristics of existing SWMUs and to identify additional SWMUs.

3.1.14.2. Continued and first-time sampling was recommended for several SWMUs at TEAD-N, including the IWL, the Pesticide/Herbicide Handling and Storage Building (SWMU 34), the Sewage Lagoons (SWMU 14), and the Sanitary Landfill (SWMU 15). Missing historical data were identified, and a radiological survey was recommended.

3.1.15. Groundwater Quality Assessment Engineering Report—1988

3.1.15.1. This report (JMM, 1988) provided additional characterization of groundwater quality in the IWL area (SWMU 2). Twelve new monitoring wells were installed, and sampling and analysis was continued at 19 existing wells for VOCs, selected metals, and major cations and anions.

3.1.15.2. Significant concentrations of several VOCs were detected in TEAD-N monitoring wells, including trichloroethylene, 1,1,1-trichloroethane, and carbon tetrachloride. Major cations and anions were found to increase in concentration with depth and distance along flow lines. Montgomery Watson recommended an additional six monitoring wells to evaluate the distribution of contaminants in unmonitored zones, specifically from 250 to 450 feet below ground surface.

3.1.16. Preliminary Assessment/Site Investigation—1988

3.1.16.1. Between September 1985 and November 1987, EA Engineering Science and Technology, Incorporated, performed a data review and conducted preliminary field sampling and analysis at TEAD-N and TEAD-S, with the objective of identifying

SWMUs at TEAD that presented a known or potential threat to public health or the environment (EA, 1988). The investigation involved a review of existing databases, including information provided by USATHAMA, for potential source information. A site inspection, including personnel interviews, was carried out, and five monitoring wells and four lysimeters were installed. Existing monitoring wells and surface soil and sediment were sampled and analyzed for metals, explosives, VOCs, and SVOCs.

3.1.16.2. Explosives were detected in the soil and sediments at the TNT Washout Facility (SWMU 10), and either discontinuing or relocating the Laundry Facility, or installing an impermeable liner beneath the Laundry Effluent Pond (SWMU 11) were recommended. The study recommended additional monitoring wells at the TNT Washout Facility, Drum Storage Areas (SWMU 29), Chemical Range (SWMU 7), and X-ray Lagoon (SWMU 3), as well as additional soil borings at the TNT Washout Facility.

3.1.17. Remedial Investigation—1989

3.1.17.1. This Remedial Investigation (RI) was conducted by Roy F. Weston for USATHAMA with the objective of summarizing and reviewing data from previous investigations and identifying and investigating data gaps for the TNT Washout Facility (SWMU 10), Chemical Range (SWMU 7), Old Burn Area (SWMU 6), Sanitary Landfill (SWMU 15), and Drum Storage Areas (SWMU 29; Weston, 1990). The associated field investigation consisted of 30 boreholes for soil characterization, 28 monitoring wells for groundwater evaluations, and a geophysical survey for old burial areas. Groundwater and soil samples were analyzed for metals, VOCs, SVOCs, explosives, and major cations/anions.

3.1.17.2. Low concentrations of explosives were detected in shallow soil around the TNT Washout Facility (SWMU 10), and additional monitoring wells were recommended to characterize the perched groundwater zone in that area. Benzene, 1,2-dichloroethane, and trichloroethylene all were detected in groundwater at the Sanitary Landfill (SWMU 15). The Drum Storage Areas (SWMU 29) had limited soil/groundwater contamination, and surface soil samples collected at the Chemical Range (SWMU 7) and Old Burn Area (SWMU 6) had low concentrations of metals. The study noted that additional monitoring wells were required to characterize the groundwater zone between the Sanitary Landfill and the Sewage Lagoons (SWMU 14), and recommended continued sampling of existing wells.

3.1.18. Groundwater Quality Assessment for Tooele Army Depot; Tooele, Utah—1991

3.1.18.1. The focus of this groundwater quality assessment was the contamination associated with the IWL and wastewater ditches (ESE, 1991), and the objective was to provide additional groundwater elevation and analytical data for evaluating corrective actions. Groundwater elevation measurements were obtained from 140 existing piezometers and monitoring wells, and groundwater samples were collected from 26 existing wells.

3.1.18.2. This assessment verified that conditions at TEAD-N were similar to those reported in previous investigations. Groundwater flowed in a north to northwest direction. Contaminants detected during this investigation and the position of the trichloroethene plume were similar to results from the 1988 JMM and 1990 Weston reports.

3.1.19. Pre-Construction Soil Sampling at the DRMO Storage Yard and the Drum Storage Areas—1992

3.1.19.1. Tetra Tech, Inc., under the supervision of facilities personnel, sampled soil at both the DRMO Storage Yard (SWMU 26) and the Drum Storage Areas (SWMU 29) for a pre-construction environmental assessment (EA), under the National Environmental Policy Act (NEPA; Tetra Tech, 1992). The following summarize the sampling activities and results:

- Tetra Tech personnel collected soil samples from five locations at the DRMO Storage Yard (SWMU 26) at depths ranging from 6 to 24 inches below ground surface, and submitted two samples from each location, for a total of 10 soil samples, for analysis by the Toxic Characteristics Leaching Procedure (TCLP) method (EPA Method 1311). The samples were in the vicinity of a proposed building. Seven of the samples contained detectable concentrations of cadmium in the leachate, and one analysis slightly exceeded the RCRA regulatory limit of 1.0 mg/L for cadmium.

- Soil was sampled at 14 locations at the Drum Storage Areas (SWMU 29). Two soil samples were collected from each location for a total of 28 samples. All samples were submitted for TCLP analysis. These samples were collected

in advance of construction of four new buildings and repair of one existing structure. None of the samples had analytes that exceeded the RCRA regulatory limits.

3.1.20. Removal Action Assessment at the Bomb Washout Building (SWMU 42)

3.1.20.1. In May 1993, the AEHA conducted a Removal Action Assessment at SWMU 42 to determine the extent of contamination from previous demilitarization activities (AEHA, 1993). A Health Risk Assessment was also completed based on the results of this study. Risks were assessed because the levels of contamination determined by the Phase I RFI (MW, 1993) could pose an imminent health risk to workers that currently occupy Building 539 and surrounding areas. Twenty-seven surface samples were collected in a grid pattern along three sides of the former Bomb Washout Facility and submitted for metal analyses (barium, beryllium, cadmium, lead) and for the explosives 2,4-DNT and 2,6-DNT. Thirteen samples were also submitted for TCLP metals analysis.

3.1.20.2. The conclusions from the AEHA assessment are as follows:

- Personnel working within the marine vehicle maintenance facility are not at risk from contaminated soil.
- Personnel should be prohibited from areas north and west of Building 539 and the vehicle storage yard, where the lead concentrations exceed 1,000 mg/kg in soil, until the site is remediated in the future.
- Based on the TCLP analyses, soil contaminated with more than 1,000 mg/kg lead would require management as a hazardous waste if removed as part of a future remedial action.

3.1.20.3. Recommendations from this assessment included prohibiting personnel from areas where lead contamination exceeds 1,000 mg/kg, and managing any excavated soil resulting from future remedial activities as a hazardous waste in those areas where lead concentrations exceed 1,000 mg/kg.

3.2 RCRA FACILITY INVESTIGATION METHODOLOGY

3.2.0.1. As indicated in the introduction to this report (Section 1.0), Montgomery Watson conducted a RCRA Facility Investigation (Phases I and II) at TEAD-N during the period from 1992 to 1994. The Phase I RFI investigated suspected releases of contaminants from 20 SWMUs (Montgomery Watson, 1993). Based on the Phase I RFI data, the 20 SWMUs were qualitatively prioritized for further investigation according to the degree and type of contamination present. The seven SWMUs with the highest priorities, plus a newly-designated SWMU, are collectively referred to as the "Group A Suspected Releases SWMUs." Phase I data for these SWMUs are incorporated into the SWMU-specific sections of this report (Sections 5.0 through 15.0) along with the Phase II data. The Phase I investigation and results for the remaining 13 SWMUs not included in this Phase II investigation are briefly summarized below.

3.2.1. Phase I RFI Results, Suspected Releases SWMUs

3.2.1.1. The Phase I RFI of the suspected releases SWMUs concluded by grouping each of the 20 SWMUs into one of three categories. There were two categories of SWMUs that were recommended for no further action and one category of SWMUs recommended for a Phase II RFI. Further descriptions of these three categories and the SWMUs included in each are briefly described in this section.

3.2.1.2. SWMUs Recommended for No Further Action. The Phase I RFI found no indication that a release of contaminants had occurred at three of the 20 suspected releases SWMUs. These SWMUs were designated as needing no further action, in accordance with the Corrective Action permit for TEAD-N. Reasons for no further action were presented at a public meeting on September 23, 1993 and are summarized below.

3.2.1.3. Solvent Recovery Facility (SWMU 39). This facility is relatively new, equipped with adequate containment features, and follows proper work management practices. No spills of reportable quantities have occurred at this facility.

3.2.1.4. Container Storage Areas For P999 and Mustard Agent-Filled Mortar Rounds (SWMU 43). This SWMU consists of six igloos where M55 rocket components were stored, and 12 igloos in which mustard agent-filled mortar rounds were stored. The rocket components did not contain or contact chemical agents or warheads, and therefore

these six igloos were not investigated. In addition, a records review of available information found no indication of leaks from the mustard agent-filled mortar rounds. Thus, no additional investigation of the other igloos was required.

3.2.1.5. Tank Storage For Trichloroethene (SWMU 44). This SWMU is located at the southern end of Building 620 in the Maintenance Area, where trichloroethene was stored in a 500-gallon tank. Spent trichloroethene from the tank was discharged into sewers that emptied into the IWL. Use of the tank ceased in 1984, and in 1991 it was turned over to the DRMO Yard for salvage. Because neither the tank nor any contamination from the tank remains at the site, no further action was required.

3.2.1.6. SWMUs Recommended for No Further Action Under RCRA Corrective Action. The following SWMU, not included with the Group A SWMUs, was recommended for no further action under the existing TEAD Corrective Action Permit.

3.2.1.7. RCRA Container Storage (SWMU 27). Seven surface soil samples were collected from the RCRA container storage yard. One sample was taken beneath each of the four drain pipes and three from open areas inside the fence where drums were stored. All samples were analyzed for VOCs, SVOCs, and metals. Although several metals were detected in the samples, none exceeded action levels. Because additional sampling and site characterization will be required according to the RCRA treatment, storage and disposal permit for this facility, when it closes, no further action under the RCRA corrective action permit was recommended.

3.2.1.8. SWMUs Recommended for Phase II RFI. Phase I RFI sampling results at the remaining Suspected Releases SWMUs concluded that chemicals had been released to the environment from each of these nine SWMUs. A summary of the Phase I sampling activities and their results are summarized below.

3.2.1.9. Sand Blast Area (SWMU 4). Two samples were taken from near each of the three spent sand blast media collection points (six total). Nearby surface soil and surface water runoff pathways were sampled and all samples were analyzed for VOCs, SVOCs, and metals. Elevated metals were detected in all of the samples, most frequently cadmium, lead, and barium. SVOCs were also detected. Based on these results, Phase II investigation and a risk assessment were recommended for this SWMU.

3.2.1.10. Sewage Lagoons (SWMU 14). The objective of investigating this SWMU was to determine if the sewage lagoons were contributing contaminants to the groundwater beneath this portion of TEAD-N. Two surface water samples and two sediment samples were collected from the north lagoon and two sediment samples were taken from the south lagoon (no water samples were collected because the lagoon was dry). Two rounds of groundwater sampling were conducted at five monitoring wells in the area. All samples were analyzed for VOCs, SVOCs, total recoverable petroleum hydrocarbons (TRPH), metals, and anions. Based on the analytical results, the sewage lagoon wastewater was not thought to be contributing organic compounds or metals to groundwater. However, because several organic compounds were detected in sewage lagoon pond water and elevated metals were present in sediment, the sewage lagoons were recommended for Phase II investigation and risk assessment.

3.2.1.11. AED Demilitarization Test Facility (SWMU 19). During the Phase I RFI, twelve surface soil samples were collected to provide general coverage of SWMU 19 and focus on the active areas. All samples were analyzed for total metals, explosives, VOCs, SVOCs, and anions. Metals, explosives, and several SVOCs were detected intermittently in the samples as was elevated nitrate. Based on these results, a Phase II investigation and risk assessment were recommended for this SWMU.

3.2.1.12. DRMO Storage Yard (SWMU 26). The Phase I RFI sampling program at the DRMO yard consisted of collecting 45 surface soil samples and 15 shallow soil samples (from 1 to 3 feet bgs) from random cells in a sampling grid that covered the area. All samples were analyzed for VOCs, SVOCs, metals, and cyanide. Metals, cyanide, and SVOCs were all detected. To further evaluate this SWMU, a Phase II investigation and a risk assessment were recommended for this SWMU.

3.2.1.13. 90-Day Drum Storage Area (SWMU 28). Sampling at the 90-Day Drum Storage Area consisted of collecting eight samples of surface soil from areas where ground was stained. Samples were analyzed for total metals, VOCs, SVOCs, and TRPH. Chemicals detected included elevated metals, volatile and semi-volatile organic compounds, and total petroleum hydrocarbons. Because areas of ground staining were targeted by the sampling program, widespread contamination was not suspected. However, because activities at this SWMU had released contaminants to the environment, Phase II investigation and risk assessment were recommended.

3.2.1.14. Drum Storage Areas (SWMU 29). Soil at SWMU 29 was investigated using 37 soil borings advanced to 5 feet bgs. Borings were located in areas where aerial photographs indicated drums had been stored and in surface water runoff pathways. Two samples were collected from each boring. All surface soil samples were analyzed for metals and pesticides, and several were analyzed for VOCs, SVOCs, explosives, and TRPH. All of the deeper samples were analyzed for metals, pesticides, VOCs, SVOCs, and TRPH. Chemicals detected included elevated metals, VOCs, SVOCs, pesticides, and TRPH. Based on these results, additional Phase II investigative activities and a risk assessment were recommended for this SWMU.

3.2.1.15. Industrial Wastewater Treatment Plant (SWMU 38). Five samples were collected from the Industrial Wastewater Treatment Plant (IWTP): four from surface soil on the west side of the plant, and one sample of spent granular activated charcoal (GAC) collected from a shipping container stored in the area. The soil and GAC samples were analyzed for metals, VOCs, and SVOCs. The sample of GAC was also analyzed for metals, VOCs, and SVOCs using the TCLP method. Based on the analytical results of these samples, low concentrations of several metals and SVOCs had been released to the surface soil on the west side of SWMU 38. Because of this, Phase II investigative activities and a risk assessment were recommended for this SWMU.

3.2.1.16. Used Oil Dumpsters (SWMU 46). Eighteen surface soil samples and eighteen shallow soil samples (1 foot bgs) were analyzed for TRPH at the used oil dumpster locations. Analytical results indicated that TRPH had been released to the surface and shallow soils at virtually all of the locations sampled. Based on these results, additional sampling under a Phase II investigation and a risk assessment were recommended for this SWMU.

3.2.1.17. Boiler Blowdown Areas (SWMU 47). Samples collected during the Phase I RFI included a sample of surface water from a boiler blowdown water sump outside Building 610, a surface soil sample adjacent to this sump, a sample of sediment from a boiler blowdown water discharge area outside Building 600, and a sediment sample and surface water sample from a discharge area west of Building 691. All samples were analyzed for VOCs, SVOCs, metals and TRPH. Surface water samples had detectable VOCs and SVOCs, as well as a small amount of cyanide in the sample collected west of Building 691. The sediment samples contained TRPH and several metals. Based on these results, the boiler blowdown activities had released chemicals to the environment,

and further sampling under a Phase II investigation and a risk assessment were recommended for SWMU 47.

3.2.2. Phase II RFI Methodology, Group A Suspected Releases SWMUs

3.2.2.1. During the fall of 1993 and spring of 1994, Montgomery Watson conducted Phase II RFI field work for the Group A Suspected Releases SWMUs at TEAD-N. The objective of this investigation was to delineate the vertical and horizontal extent of contamination identified during the Phase I RFI, and to perform a human health and ecological risk assessment for each of the Group A SWMUs. A comprehensive description of the Phase II RFI field sampling program is included in the DCQAP prepared for this project (MW, 1993a). Detailed information from the Phase II RFI field activities is included in Appendix A, and supporting data from the various Phase II investigative programs are included in other appendices. Results of the Phase II RFI are incorporated into the SWMU-specific sections of this report (Sections 5.0 through 15.0), which describe the environmental conditions and risks at each SWMU.

3.2.3. Field Sampling Program Overview

3.2.3.1. Field investigations at the eight Group A SWMUs included sampling air, soil, sediment, surface water, and groundwater to delineate the vertical and horizontal extent of contamination discovered during the previous Phase I sampling program. Ecological, geophysical, and topographical surveys supplemented the field sampling. Descriptions of the investigation programs at each SWMU are included in Appendix A. Appendix B contains boring, surface soil sampling, and test pit excavation logs. A discussion of the validation and management of the analytical data generated is included as Appendix E. The remainder of this subsection provides an overview of the major Phase II RFI sampling activities.

3.2.3.2. Surface Soil Sampling. Surface soil samples were collected at SWMUs 1, 20, 21, 37, and 42 to further define the nature and extent of contaminants detected during the Phase I investigation. Samples were collected from the top three to six inches of soil using a decontaminated stainless steel spoon. With the exception of the surface soil samples collected at SWMUs 1 and 21, and dioxin/furan, hexavalent chromium, and chromium samples collected at SWMUs 20 and 42, surface samples were composited from five aliquots evenly distributed on a 5-foot radius from the central sampling

location. This technique distributes each sample over a larger sampling area, providing a more representative measure of soil conditions.

3.2.3.3. Hand Auger Sampling. Six 3-foot soil borings were advanced by hand auger at SWMU 37 to further delineate the horizontal and vertical extent of contaminants detected during the Phase I investigation. Three samples were collected per boring for a total of 18 soil samples. Two 3-foot borings were hand augered at SWMU 42 at locations where furnace wastes had been dumped on the surface. Two samples were collected per boring from below the waste piles, for a total of four soil samples.

3.2.3.4. Hollow Stem Auger Sampling. Hollow stem auger drilling and sampling techniques were used to collect soil samples from depths of up to 20 feet at SWMUs 20, 34, 42, 45, and 48. Soil samples were collected using decontaminated split-spoon samplers. The purpose of these soil samples was to further define the horizontal and vertical extent of contaminants detected during the Phase I RFI. Hollow stem auger drilling and sampling techniques were also used to collect background samples included in the Phase II RFI program.

3.2.3.5. Deep Borehole Sampling. To determine the vertical extent of contamination at SWMU 42 resulting from surface water infiltration from the wastewater ditch and holding pond, a total of four 100-foot deep boreholes were drilled and sampled during the Phase II RFI. Each boring was advanced using a percussion-type, dual-walled, reverse-circulation air hammer drilling rig. Five samples per boring were collected for laboratory analysis using decontaminated split-spoon samplers.

3.2.3.6. Monitoring Well Installation and Development. The same drill rig used for the deep borehole sampling at SWMU 42 was used to drill and install two deep monitoring wells at SWMU 45. These wells were installed to assess whether continuous water ponding at the Stormwater Discharge Area affected the groundwater. Upgradient and downgradient wells N-142-93 and N-143-93 were installed to depths of 377 feet and 346 feet, respectively. Between three and seven days after installation, each well was developed by bailing and pumping until the turbidity was less than five nephelometric units and at least five times the saturated borehole volume of water had been removed. Monitoring well construction and development records are included in Appendix C.

3.2.3.7. Monitoring Well Sampling and Slug Testing. Two rounds of groundwater sampling were conducted during the Phase II RFI. The two new monitoring wells

(N-142-93 and N-143-93) and existing monitoring well T-7 were sampled to investigate the local groundwater conditions at SWMU 45. The first sampling round was conducted November 22 and 23, 1993. The second sampling round took place on February 1 and 2, 1994. Rising head hydraulic conductivity tests (slug tests) were performed in conjunction with the sampling activities to gather information on the permeability of the formation in which the wells are screened. The slug test results and plots of the data are included in Appendix C.

3.2.3.8. Sediment and Surface Water Sampling. Sediment and surface water samples were collected at SWMU 21. The surface water sample was collected from a cattle watering trough that occasionally is used by wildlife in the area. The two sediment samples were collected from an adjacent wet area caused by overflow from the watering trough. Surface water and groundwater sampling information is included in Appendix D.

3.2.3.9. TSP Sampling and Meteorological Monitoring. Air was sampled for total suspected particulates (TSP) at SWMU 42 during the Phase II RFI. The purpose of the air sampling program was to assess the potential exposure to on-site workers from contaminants in fugitive dust. Four air monitoring stations were set-up for two rounds of air sampling, which was conducted during October and November, 1993. Two composite samples were collected from each of the four stations for a total of eight TSP samples. Meteorological data consisting of wind speed, wind direction, and temperature were also collected during the air monitoring program to provide the background information necessary to interpret the monitoring data. Appendix H contains the TSP sampling methodology and results.

3.2.3.10. XRF Sampling. To evaluate the extent of lead contamination at SWMU 42, X-ray fluorescence (XRF) methods were used to screen 135 surface soil samples. These soil samples were analyzed in the field to allow rapid delineation of the extent of metals contamination. Results from these analyses were also used to help place shallow soil borings at this SWMU. To calibrate the XRF results, eight surface soil samples were submitted for laboratory analysis. Appendix G contains descriptions of the XRF sampling and analysis techniques and a summary of the results.

3.2.3.11. Ecological Survey. During the Phase II RFI field program, Montgomery Watson and its ecological subcontractor visited each SWMU to observe faunal species and characterize major vegetation types. These field activities gathered information for

the ecology discussion in Section 2.0 and for the ecological risk assessments for each of the Phase II SWMUs.

3.2.3.12. Topographic Survey. To assign Utah state plane coordinates and elevations to critical locations, the following sites were surveyed: the two newly installed monitoring wells at SWMU 45, the four 100-foot borings at SWMU 42, and the four air monitoring stations. All other sampling points from the Phase II RFI were tied to existing reference locations surveyed during the Phase I RFI. A summary of topographic survey data and other sample, borehole, and test pit location information is included as Appendix I.

3.2.3.13. Geophysical Survey. Approximately 100,000 linear feet of geophysical traverses were conducted on a 15-foot spacing across the fields west and north of the Bomb Washout Building (SWMU 42). Portable magnetometer, non-ferrous metal detector, and soil conductivity surveys were used to locate debris on the surface and in the shallow subsurface. Geophysical anomalies identified by these surveys were used to site seven excavation test pits for further subsurface investigations. Appendix F contains the results of the Geophysical Surveys.

3.2.3.14. Test Pit Excavation. Seven excavation test pits were sited at SWMU 42 based on the geophysical results. Test pits were used to evaluate the nature and extent of debris buried in the open field just west of the furnace locations. Four soil samples were collected from the test pits to evaluate possible metals contamination. Test pit logs are included in Appendix B.

3.2.3.15. Stormwater Line Video Survey. To look for potential leaks in the stormwater system, approximately 7,000 feet of pipeline at SWMU 45 were inspected and videotaped using a specially-designed, track-mounted sewer line camera. The videotape provides a record of the stormwater pipeline condition and allows cracked or separated pipeline sections to be located with respect to the surface manholes and other features. These areas of potential leaks were then targeted for subsequent auger drilling and sampling.

3.2.4. Contamination Assessment Methodology

3.2.4.1. Introduction. An assessment methodology was developed to standardize the description of the chemicals detected at each of the SWMUs addressed in this Phase II RFI. The goal of this methodology was to meet the requirements of RCRA, the TEAD-N corrective action permit, and the USAEC scope of work for this project. The next several

paragraphs present the contamination assessment methodology that will be used as a template in each of the SWMU-specific discussions included in Sections 5.0 through 15.0 of this report.

3.2.4.2. Data Quality Assessment. Montgomery Watson completed a data quality assessment on all analyses from both RFI phases. Appendix C of the Phase I RFI (Montgomery Watson, 1993) and Appendix E of this document summarize the analytical programs and contain details of the data quality assessments of each SWMU. The analytical data were reviewed in accordance with the criteria presented in the following documents:

- TEAD-N Suspected Release RFI Phase I Study, Data Collection Quality Assurance Plan (DCQAP) (JMM, 1992)
- TEAD-N Phase II RFI, Group A, Suspected Releases SWMUs, DCQAP (MW, 1993)
- USATHAMA Quality Assurance Program (USATHAMA, 1990)
- User's Guide, IRDMIS Volume II Data Dictionary, Potomac Research Institute (PRI) (PRI, 1991)
- USEPA National Functional Guidelines for Evaluation of Organic and Inorganics Analyses (USEPA, 1988)
- USEPA National Functional Guidelines for Evaluation of Organics Analyses (USEPA, 1991).

3.2.4.3. Sampling Results. The combined results of all validated analyses from both RFI phases that are thought to represent environmental contamination are summarized in figures in each SWMU-specific writeup. The figures present all detected organic compounds (VOCs, SVOCs, explosives, pesticides, and dioxins/furans); metals are included only if their concentrations are above background. Appendix O contains tabular summaries of selected data (hits only tables) from both Phase I and Phase II investigation phases. A comprehensive listing of all the Phase II RFI analytical data and the Phase II RFI data validation summary are included as appendices P and E, respectively, in this

report. The supporting Phase I RFI analytical data and the Phase I RFI data validation summary are presented in the Phase I RFI report (MW, 1993),

3.2.4.4. Compounds or elements considered not detected due to their presence in method blanks or other associated QA samples were not included on the results figures, nor were they included in the contamination assessment. The basis for determining whether or not a compound is considered a laboratory or sampling artifact has been established in the document *National Functional Guidelines for Organic Data Review* (USEPA, 1994). In addition, the common phthalate esters, because of their common occurrence in many products (e.g., PVC piping, Tygon tubing, hoses, laboratory funnels, etc.), are considered not detected at concentrations less than 10 mg/kg. The possibility that concentrations in this range are due to laboratory or sampling contamination is high enough to discount their occurrence as environmental contamination.

3.2.4.5. Nature and Extent of Contamination. Each SWMU-specific contamination assessment includes a discussion of the nature and extent of environmental contamination. The nature of contamination is described in terms of the anthropogenic chemicals detected (chemicals detected above background thresholds, see Section 4.0) and their concentrations. To provide a relative measure of the significance of these chemicals and their risk to human health, the concentrations are compared with those listed in a USEPA risk-based screening table (USEPA, 1994a). Values in this table, included as Table 3-1, were developed by EPA Region III and are used to provide benchmarks for putting soil data into perspective relative to generic residential and construction worker exposure scenarios. The chemical concentrations listed in this table correspond to human risks that have a hazard quotient greater than 1 or a lifetime cancer risk greater than 10^{-6}, under each scenario.

3.2.4.6. The extent of contamination is discussed in terms of lateral and vertical extent based on the analytical results. Because of the generally sporadic detection of contaminants at most SWMUs, contaminant volume calculations would be inaccurate and have not been developed for this RFI.

3.2.5. Evaluation of Contaminant Fate and Transport

3.2.5.1. Introduction. The following paragraphs contain background information for contaminant fate and transport evaluations at TEAD-N, and will be used as a reference for the specific fate and transport discussions included for each SWMU (Sections 5.0

TABLE 3-1

EPA REGION III RISK-BASED CONCENTRATION LEVELS (b)

Contaminant	Soil Contaminant Concentration That Triggers a Health Risk > 1 or a Cancer Risk > 1.0E-06 Residential Scenario (mg/kg)	Commercial/Industrial Scenario (mg/kg)
INORGANIC		
Antimony	31	410
Arsenic (as carcinogen)	0.37	1.6
Barium	5,500	72,000
Beryllium	0.15	0.67
Cadmium	39	510
Chromium III	78,000	1,000,000
Chromium VI	390	5100
Copper	2,900	38,000
Cyanide	1,600	20,000
Lead (a)	400	5,000
Manganese	390	5,100
Mercury	23	310
Nickel	1,600	20,000
Selenium	5,100	390
Silver	390	5,100
Thallium	6.3	82
Vanadium	550	7,200
Zinc	23,000	310,000
VOCs		
Ethylbenzene	100,000	7,800
Tetrachloroethene (PCE)	12	55
Toluene	16,000	200,000
Trichloroethene	58	260
Xylene (total)	23,000	310,000
SVOCs		
1,2,4-Trichlorobenzene	780	10,000
Acenaphthalene	4,700	61,000
Anthracene	23,000	310,000
Benzo[a]anthracene	0.88	3.9
Benzo[a]pyrene	0.088	0.39
Benzo[b]fluoranthene	0.088	0.39
Benzo[g,h,i]perylene	0.088	0.39
Benzo[k]fluoranthene	8.8	39
Bis(ethylhexyl) phthalate	46	200

All reported values obtained from EPA Region III Risk-based standard tables for the residential and commercial/industrial scenarios (USEPA, 1994a).

(a) Value for lead is not reported on the EPA Region III Risk-based standard tables. The lead value for the residential scenario is a screening level from the Revised InterimSoil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities(USEPA, 1994c); the value for the commercial/industrial scenario is a maximum soil industrial level from the same document.

(b) Chemical concentrations in soil that trigger a health or cancer risk - using the residential and commercial/industrial scenarios

TABLE 3-1

EPA REGION III RISK-BASED CONCENTRATION LEVELS (b)
(CONTINUED)

Contaminant	Soil Contaminant Concentration That Triggers a Health Risk > 1 or a Cancer Risk > 1.0E-06: Residential Scenario (mg/kg)	Commercial/Industrial Scenario (mg/kg)
SVOCs (continued)		
Chrysene	390	88
Di-n-butylphthalate	7,800	100,000
Fluoranthene	3,100	41,000
Fluorene	3,100	41,000
Indeo[1,2,3-cd]pyrene	0.87	3.9
n-Nitrosodiphenylamine	130	581
Napthalene	3,100	41,000
Pryrene	2,300	31,000
EXPLOSIVES		
1,3,5-Trinitrobenzene	3.9	51
1,3-Dinitrobenzene	7.8	100
2,4,6-Trinotrotoluene	21	95
2,4-Dinitrotoluene	160	2,000
2,6-Dinitrotoluene	78	1,000
HMX	3,900	51,000
Nitrobenzene	39	510
RDX	5.8	26
DIOXIN/FURANS		
Dioxins (2,3,7,8,-TCDD)	0.0000043	0.000019
PESTICIDES		
2,4-D	780	10,000
alpha Chlordane	0.1	0.45
Endrin	23	310
Heptachlor	0.14	0.64
Lindane	0.49	2.2
p,p-DDD	2.7	12
p,p-DDE	1.9	8.4
p,p-DDT	1.9	8.4

All reported values obtained from EPA Region III Risk-based standard tables for the residential and commercial/industrial scenarios (USEPA, 1994a).

(a) Value for lead is not reported on the EPA Region III Risk-based standard tables. The lead value for the residential scenario is a screening level from the Revised InterimSoil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities(USEPA, 1994c); the value for the commercial/industrial scenario is a maximum soil industrial level from the same document.

(b) Chemical concentrations in soil that trigger a health or cancer risk - using the residential and commercial/industrial scenarios

through 15.0). Included in this section are discussions of the physical and chemical characteristics and the mobility of the chemicals of concern at TEAD-N. The fate and transport of anions (with the exception of cyanide), which tend to be mobile in most soil environments and are subject to leaching, will not be discussed in this section.

3.2.5.2. Because of the complexity of the geology at the various SWMUs and the variety and distribution of chemical compounds present, it is not practical to quantitatively evaluate the fate and transport of contaminants. Therefore, fate and transport of contaminants at TEAD-N will be discussed in a qualitative and descriptive manner.

3.2.5.3. The remainder of this subsection is divided into two parts: (1) Contaminant Characteristics and Transport Parameters, and (2) Fate and Mobility of the Contaminants of Concern. In the contaminant characteristics subsection, the physical and chemical parameters that influence the fate and transport of contaminants in the environment are discussed. The contaminant migration subsection will qualitatively evaluate the fate and mode of both organic and inorganic contaminant transport in terms of the chemical and physical properties of the contaminants.

3.2.5.4. Contaminant Characteristics And Transport Parameters. The transport of a contaminant in unsaturated and saturated environments at TEAD-N is influenced by the following general processes:

- Advection - The physical process of contaminant transport (in solution) at the average linear velocity of groundwater in the direction of groundwater flow

- Adsorption/Desorption - Retardation in movement of contaminants compared to water because of adsorption to the soil

- Complexation - Bonding of a metal to anionic or neutral species that affects solubility and adsorption

- Diffusion - The chemical process that results in the movement of contaminants in response to concentration gradients

- Dispersion - The mechanical process of mixing that results from local variations in the average velocity of groundwater

- Ion Exchange - Retardation in movement of contaminants compared to water because of incorporation of the contaminant into the soil matrix

- Solubility - The amount of contaminant that can be dissolved in water or another liquid

- Transformation - The loss or degradation of contaminants from the environment as a result of chemical reactions or microbial activity

- Volatilization - The transfer of contaminants from the liquid phase to the vapor phase into either the soil gas (in unsaturated environments) or the atmosphere.

3.2.5.5. The chemical and physical properties of inorganic and organic compounds influence their fate and transport in the environment. The behavior of organic compounds can be estimated using environmental fate parameters such as Henry's Law Constants and adsorption coefficients, which relate the physical and chemical properties of the individual compound to the environment. Compound-specific fate and transport parameters generally are not applicable to inorganic compounds. The fate of inorganic compounds depends primarily on the solubility of the individual compound, which is determined by the pH, reduction-oxidation potential, and temperature of the environment. The following sections focus on the chemical and physical properties that influence the fate and transport of inorganic and organic compounds in the environment.

3.2.5.6. Inorganic Contaminants. The chemical and physical characteristics and reactions that potentially govern the fate and transport of the inorganic contaminants found at TEAD-N are oxidation-reduction (redox) reactions, solubility/precipitation, adsorption/desorption, ion exchange, and complexation. These reactions or processes are interrelated, which greatly complicates the fate and transport of inorganic species. Each of these properties or chemical reactions is described briefly in the following paragraphs. It should also be noted that some inorganic species occur naturally while others may have been present in contaminant releases to the environment.

3.2.5.7. Oxidation-reduction reactions involve changes in the oxidation states of elements. Redox conditions in soil and groundwater are determined primarily by the relative rates of oxygen introduction and consumption of oxygen by bacterially mediated decomposition of organic matter (or occasionally sulfides or ferrous silicates; Drever,

1982). The redox potential (Eh) in soil, surface water, and groundwater is also controlled by redox buffers, such as iron and manganese oxides and hydroxides, and the fact that reactions that lower redox potential are slow. Vadose zone and saturated soil typically have large proportions of iron and manganese hydroxides and oxides, and these species can control the redox levels in soil, porewater, and groundwater solutions by buffering redox reactions.

3.2.5.8. The concentrations that inorganic contaminants can theoretically reach in porewater, surface water, and groundwater can be estimated based on principles of equilibrium chemistry (solubilities). The maximum concentrations of dissolved inorganic ions, such as calcium or chromium, in porewater or groundwater can be calculated using the thermodynamic solubility constants of solid phases that contain the dissolved ion. If the solubility of a mineral phase is exceeded, the dissolved species should begin to precipitate. As an example, if leachate high in sulfate recharges a hydrostratigraphic unit containing groundwater that is in equilibrium with gypsum (calcium sulfate), the solubility of gypsum would be exceeded, and gypsum would precipitate until chemical equilibrium was again reached. In natural systems there are many factors that complicate the application of chemical equilibrium principles. For instance, even if a certain mineral phase is oversaturated in groundwater it may not precipitate because the precipitation kinetics are slow. Additionally, the dissolution kinetics of a mineral may be slower than the rate of infiltrating porewater or groundwater flow, and the porewater or groundwater may never reach saturation with respect to that mineral. Many minerals contain the same ions, and the contribution of an ion from one mineral affects the solubility of another mineral containing the same ion (referred to as the common ion effect; Stumm and Morgan, 1981). Further, differences in redox conditions and/or pH within localized sections of the soil column or aquifer can affect the solubility of minerals in porewater or groundwater.

3.2.5.9. Surface adsorption/desorption can play an important role in the fate and transport of inorganics, particularly for positively charged metal ions. Adsorption and desorption depends on the surface charge, the dissolved ion and its charge, and the pH of the soil. The adsorption of inorganics to solid surfaces is similar to that of organics. However, most data on partitioning of inorganics between the aqueous and solid phases are either empirical and specific to the conditions in which the experiment was performed, or are based on field observations at a specific site. Hence, data obtained from laboratory experiments or field observations may not predict the adsorption and desorption reactions that may influence the transport of a certain element at a particular

site. However, positively charged metal ions, such as trivalent chromium, cadmium, lead, iron, manganese, and zinc, tend to be adsorbed, and the transport of these species likely will be slower than the groundwater or pore water velocity.

3.2.5.10. Ion exchange is similar to adsorption, but has key mechanistic differences. Adsorption is viewed as the coordination bonding of metals (or cations) to specific surface sites that are considered to be two-dimensional, while ion-exchange is visualized as taking place in a three-dimensional porous matrix containing fixed charges (Johnson and others, 1989). In ion exchange, the ions are held by electrostatic forces rather than by coordination bonding. Clay minerals are some of the most important ion exchangers because they have a large electrical charge relative to their surface area. Ion exchange is an important process affecting fate and transport of the alkali metals (e.g., sodium and potassium), and the alkaline earth metals (e.g., barium, calcium, and magnesium). Ion exchange may influence the fate and transport of trace metals if their concentrations are high enough to compete with the more concentrated alkali and alkaline earth metals. Several inorganic contaminants may be present at high enough concentrations at TEAD-N to compete with the naturally occurring species; however, adsorption and redox reactions are probably the most important processes affecting inorganic fate and transport.

3.2.5.11. Complexes are dissolved species formed from two or more simpler dissolved species, each of which can exist in an aqueous solution (Drever, 1982). Complexes are typically formed between cations and anions, and between cations and neutral to negatively charged organic species. The negatively charged or neutral form of the complex is usually called the ligand. Simple cation and anion complexes are usually referred to as ion pairs; complexes that are more structurally complicated are referred to as coordination compounds. Ion pairs typically are less stable than coordination compounds. Formation of complexes increases the solubility of dissolved ion species by removing free ions from solution. Complexes can also stabilize a dissolved species in solution, and hence can be an important factor in the transport of inorganics, particularly transition metals such as iron, manganese, and chromium.

3.2.5.12. Organic Contaminants. The following physical parameters are used to describe contaminant mobility in unsaturated or saturated environments:

- Density
- Henry's Constant

- Vapor pressure
- Partitioning coefficients
- Solubility

Each of these physical and chemical parameters and their relation to fate and transport is described in Table 3-2.

3.2.5.13. The organic contaminants that have been detected at TEAD-N are explosives, dioxins, furans, pesticides, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds, and semi-volatile organic compounds. Table 3-3 summarizes the chemical and physical parameters of organic compounds that affect the fate and transport of these chemicals.

3.2.5.14. Contaminant Migration. Table 3-4 summarizes the general fate and transport of the inorganic and organic contaminants of potential concern detected at the Group A suspected releases SWMUs. The data presented in Table 3-4 focuses on the fate and mobility of contaminants in the various media at TEAD-N (i.e., soil, water, and air). This table also summarizes biological processes that may affect these compounds.

3.2.5.15. Fate and Mobility of Inorganics. Unlike organic compounds, metals do not degrade or transform to simpler compounds in the environment. The mobility of metals is directly related to their solubility in water or other fluids and to pH and redox conditions. In the absence of fluids to mobilize and transport metals, virtually no transport is possible. Even if fluids were present, metals will be significantly mobilized only under favorable pH and redox conditions. Movement of metals is also controlled by the solubility (pH and Eh dependent), adsorption, and redox state of the metal. With the exceptions of hexavalent chromium, arsenic, and selenium, the solubility of cadmium, lead and the other metals of concern is inversely proportional to pH. Solutions of pH 5 or less typically will increase the mobility of these metals. Because the soil at TEAD-N is generally alkaline, the potential to transport most metals to the groundwater is low. Iron, manganese and aluminum oxides, plus carbonates, hydroxides, and organic materials will cause metals to precipitate or be adsorbed onto the soil particles. Most elevated concentrations of the heavy metals appear to be in the upper 10 feet of soil at the various SWMUs, and little downward migration has occurred.

TABLE 3-2

DESCRIPTION OF PHYSICAL AND CHEMICAL PROPERTIES OF ORGANIC CONTAMINANTS THAT AFFECT TRANSPORT

Density	The mass of a chemical per unit volume. For a release of an organic liquid with low water solubility, a density of less than 1 gm/cc means that a Light Non-Aqueous Phase Liquid (LNAPL) layer may be present on the water surface; release of a liquid with a density greater than 1 gm/cc (a Dense Non-Aqueous Phase Liquid, or DNAPL) can result in the liquid displacing water in the saturated zone and downward movement of the DNAPL until the organic liquid reaches residual saturation levels in the saturated soils.
Henry's Constant	Describes the partitioning of a chemical between air and water under equilibrium conditions. The equilibrium condition applies to the water-air transfer of a chemical in unsaturated environments or the water-air contact in surface water. The higher the Henry's Law Constant, the more likely a chemical is to volatilize than remain dissolved in water.
Vapor Pressure	The concentration of a chemical in the vapor state that is in equilibrium with the pure chemical liquid or solid. The vapor pressure provides a qualitative measure of the partitioning of a chemical from the pure liquid to gaseous phase in unsaturated environments or in surface spills.
Octanol-Water Partition Coefficient (K_{OW})	A value that describes the distribution of a chemical between water and the low-polarity solvent n-octanol. K_{OW} indicates the hydrophobicity of a chemical, which is used to estimate chemical partitioning between water and lipophilic/organic media. These values are used to predict whether an organic contaminant will tend to solubilize in a hydrocarbon layer, adsorb to the organic constituents of soil, or accumulate/concentrate in tissues of fish, birds, animals or other biota.
OC-Normalized Adsorption Coefficient(K_{OC})	The soil/water partition coefficient K_{OC} (normalized for the fraction organic carbon content of the soil; f_{OC}) measures the extent that a compound will adsorb to soil or remain solubilized in water. In general, a compound with a K_{OC} of 50 or less is considered very mobile and will remain solubilized in water or a contaminant layer (Dragun, 1988).
Soil/Water Partition Coefficient(K_d)	K_d provides a soil or sediment-specific measure of contaminant partitioning between soil or sediment and water. K_d is measured, or can be estimated by multiplying the organic carbon content (f_{OC}) of the soil or sediment by K_{OC}. The higher the K_d, the more likely a chemical is to bind to soil or sediment than to remain solubilized in water.
Solubility	A quantitative measure of the mass of a chemical that will be dissolved in a unit volume of water when the chemical is in equilibrium between the two phases. The solubility of a chemical is the maximum concentration of that can exist in the true dissolved state in surface or soil water.
Viscosity	Describes the resistance of a liquid (water, LNAPL, or DNAPL) to flow. The greater the viscosity, as expressed in terms of absolute or kinematic viscosity, the more resistance there is to flow.

TABLE 3-3

PHYSICAL AND CHEMICAL PROPERTIES OF ORGANIC CONTAMINANTS

Compound	Molecular(a) Weight (grams/mol)	Density(a) (g/cm^3 @ 25°C)	Vapor Pressure (mm Hg)	H_c ($atm\text{-}m^3/mol$) (20-30°C)	Solubility (mg/L)	K_{oc} (1)	Log K_{ow} (unitless)
Explosives							
2,4,6-Trinitrotoluene	227.13	1.65	1.1×10^{-6}(k)	2.6×10^{-9}(k)	123(k)	470(k)(3)	1.6(k)
2,4-Dinitrotoluene	182.14	1.52	1.3×10^{-4}(k)	1.1×10^{-7}(k)	273(k)	260(k)(3)	1.98(k)
2,6-Dinitrotoluene	182.14	1.28	3.5×10^{-4}(k)	9.2×10^{-8}(k)	910(k)	34(k)(3)	1.9(k)
1,3-Dinitrobenzene	168.11	1.58	2×10^{-4}(k)	2.6×10^{-7}(k)	180(k)	210(k)(3)	1.49(k)
1,3,5-Trinitrobenzene	213.12	1.76	1×10^{-4}(k)	9.2×10^{-8}(k)	330(k)	77(k)(3)	1.18(k)
RDX	222.26	1.82	1×10^{-9}(k)	6.6×10^{-12}(k)	42.2(k)	7.7 to 266(k)(3)	0.87(k)
HMX	296.17	1.90	9×10^{-16}(k)	1.3×10^{-16}(k)	2.6(k)	130 to 670(k)(3)	0.13(k)
Tetryl	287.15	1.73	4×10^{-10}(k)	2.63×10^{-10}(k)	75(k)	270(k)(3)	2(k)
Dioxins and Furans							
Tetrachlorodibenzo-p-dioxins	321.96	1.83(l)	1.7×10^{-6}(c)	3.60×10^{-3}(c)	0.0002(c)	481,340(e)	6.72(c)
Heptachlorodibenzo-p-dioxins	425(m)	--	--	--	--	--	--
Heptachlorodibenzofurans	409(m)	--	--	--	--	--	--
Hexachlorodibenzo-p-dioxins	391(m)	--	--	--	--	--	--
Hexachlorodibenzofurans	395(m)	--	--	--	--	--	--
Pentachlorodibenzofurans	340(m)	--	--	--	--	--	--
Octachlorodibenzo-p-dioxins	460(m)	--	--	--	--	--	--
Octachlorodibenzofurans	444(m)	--	--	--	--	--	--
Tetrachlorodibenzofurans	306(m)	--	--	--	--	--	--
Pesticides/Herbicides							
Aldrin	364.93	--	3.75×10^{-5}(i)	0.496×10^{-3}(i)	0.02(i)	96,000(2)(c)	6.50(i)
Chlordane (alpha and gamma)	409.8	1.45; 7.53	4.6×10^{-4}(i)	4.86×10^{-5}(i)	0.1(i)	24,600(2)(c)	5.54(i)
2,4-D	221.04	--	1.05×10^{-2}(i)	1.37×10^{-10}(i)	682(i)	57(e)	--
Dieldrin	380.93	1.75	3.75×10^{-6}(i)	5.8×10^{-5}(i)	0.17(i)	1700(a)(c)	4.32(i)
Endrin	380.9	--	3.0×10^{-6}(i)	7.52×10^{-6}(i)	0.25(i)	--	--
Heptachlor	373.35	1.57	4×10^{-4}(i)	1.48×10^{-3}(i)	0.18(i)	12,000(a)(c)	5.27(i)
Lindane	290.85	--	5.57×10^{-5}(i)	2.92×10^{-6}(i)	7.3(i)	1995(e)	3.61(i)
pp-DDD	320	--	1.89×10^{-6}(i)	7.96×10^{-6}(i)	0.10(i)	770,000(2)(c)	6.20(c)

TABLE 3-3

PHYSICAL AND CHEMICAL PROPERTIES OF ORGANIC CONTAMINANTS
(CONTINUED)

Compound	Molecular(a) Weight (grams/mol)	Density(a) (g/cm^3 @ 25°C)	Vapor Pressure (mm Hg)	H_c ($atm\text{-}m^3/mol$) (20-30°C)	Solubility (mg/L)	K_{oc} (1)	Log K_{ow} (unitless)
Pesticides/Herbicides (continued)							
pp-DDE	318	--	6.5×10^{-6}(i)	6.8×10^{-5}(i)	0.04(i)	4,400,000(2)(c)	7.00(c)
pp-DDT	354.50	--	5.5×10^{-6}(i)	5.13×10^{-4}(i)	0.005(i)	243,000(2)(c)	6.19(c)
PAHs							
Acenaphthene	154.21	1.225	4.47×10^{-3}(j)	9.2×10^{-5}(j)	3.42(j)	4600(j)	4.00(j)
Acenaphthylene	154.20	0.8988	2.9×10^{-2}(j)	1.45×10^{-3}(j)	3.93(j)	5300(j)	4.07(j)
Anthracene	178.2	1.25	1.7×10^{-5}(j)	8.6×10^{-5}(j)	0.045(j)	14,000(j)	4.45(j)
Benzo(a)anthracene	228.29	1.274	2.2×10^{-8}(j)	1×10^{-6}(j)	0.009(j)	200,000(j)	5.60(j)
Benzo(a)pyrene	252.3	1.351	5.6×10^{-9}(j)	4.9×10^{-7}(j)	0.0038(j)	550,000(j)	6.06(j)
Benzo(g,h,i)perylene	276.34	1.15	1.03×10^{-10}(j)	1.44×10^{-7}(j)	0.0007(j)	1,600,000(j)	6.15(j)
Benzo(b)flouranthene	252.3	--	1×10^{-10}(j)	1.22×10^{-5}(j)	0.0043(j)	550,000(j)	6.06(j)
Chrysene	228.3	1.274	6.3×10^{-9}(j)	1.05×10^{-6}(j)	0.0015(j)	200,000(j)	5.61(j)
Fluoranthene	202.26	1.252	5×10^{-6}(j)	6.5×10^{-6}(j)	0.0022(j)	38,000(j)	4.90(j)
Fluorene	166.2	1.203	7.1×10^{-4}(j)	6.4×10^{-5}(j)	1.98(j)	7300(j)	4.20(j)
Phenanthrene	178.2	0.900	9.6×10^{-4}(j)	2.26×10^{-4}(j)	1.6(j)	14,000(j)	4.57(j)
Pyrene	202.3	1.271	2.5×10^{-6}(j)	5.1×10^{-6}(j)	0.165(j)	38,000(j)	4.88(j)
Other SVOCs							
Bis(2-ethylhexyl)phthalate	390.5	0.98(g)	2.0×10^{-7}(d)	2.5×10^{-7}(d)	0.4(g)	11,000(h)	4.5(d)
Dimethyl phthalate	194.20	1.19	1.65×10^{-3}(d)	1.1×10^{-7}(d)	4000(g)	160(h)	1.56(d)
Di-n-butyl phthalate	278.34	1.38	1.4×10^{-5}(d)	4.6×10^{-7}(d)	11.2(g)	160(o)	4.72(d)
Hexachlorobenzene	285.8	--	1.9×10^{-5}(c)	1.3×10^{-3}(i)	0.0062(l)	3900(c)	527(i)
Napthalene	128.16	0.97	0.082(i)	4.83×10^{-4}(i)	31.7(i)	1300(c)(2)	3.30(i)
n-Nitrosodiumphenylamine	74.08	--	--	--	--	--	--

TABLE 3-3

PHYSICAL AND CHEMICAL PROPERTIES OF ORGANIC CONTAMINANTS
(CONTINUED)

Compound		Molecular[(a)] Weight (grams/mol)	Density[(a)] (g/cm^3 @ 25°C)	Vapor Pressure (mm Hg)	H_c ($atm\text{-}m^3/mol$) (20-30°C)	Solubility (mg/L)	K_{oc} (1)	Log K_{ow} (unitless)
VOCs								
Ethylbenzene		106.16	0.87	9.53	8.44×10^{-3}(i)	16(i)	164(e)	3.15(i)
Toluene		92.2	0.87	28.7(b)	6.7×10^{-3}(c)	500-627(b)	300(c)(2)	2.7(h)
Xylenes	(ortho)	106.2	1.88	6.6 (25°C)(b)	4.9×10^{-3}(c)	167-213(b)	280(b)	3.1(h)
	(meta)	106.2	0.86	8.3 (25°C)(b)	6.9×10^{-3}(c)	134-196(b)	760(b)	3.1(h)
	(para)	106.2	0.86	8.9 (25°C)(b)	7.10^{-3}(c)	156-200(b)	680(b)	3.1(h)

Temperature of measurement is 20°C unless indicated.

-- No commonly used values found.
(1) Unless otherwise noted K_{oc} is unitless.
(2) ml/g
(3) mg/kg

Sources of information:

(a) Handbook of Chemistry and Physics (1987)
(b) Mackay and Shiu (1981)
(c) EPA (1986)
(d) Little (1985)
(e) Dragun (1988)
(g) Dean (1985)
(h) Sangster (1989)
(i) Howard (1990)
(j) ATSDR (1989)
(k) Layton and others (1987)
(l) ATSDR (1989c)
(m) Calculated from structure

TABLE 3-4

FATE AND TRANSPORT OF TEAD-N CHEMICALS OF POTENTIAL CONCERN
(1 of 7)

Chemical	Soil	Water	Air	Biological Systems
INORGANIC COMPOUNDS				
Aluminum, present as A1(III) cation (Alloway, 1990; Hem, 1985)	Will readily adsorb soils, and form oxides and inorganic complexes.	Virtually insoluble except at very low pH. Under normal pH conditions, will readily form hydroxides and polymerize. Will form organic complexes in the presence of "humic" material.	Not volatile, may adsorb to airborne particles.	Metals may be reduced.
Antimony, may be present in several oxidation states (Sb III) to (Sb V) (Alloway, 1990; Hem, 1985)	Will be moderately mobile in soil and will likely occur as antimonate in soluble form at normal Eh/pH ranges. Only low adsorption by soil components over long duration (especially at elevated pH). May be adsorbed by clays and hydrous oxides and will complex with soil humates.	Solubility in water of oxidized form is strongly attenuated by sorption to sediment.	Oxidized forms are not volatile, but may absorb to airborne particulates. Reduced forms may be subject to biomethylation and be volatile.	Metals may be reduced. Will readily be taken up by many plant species. Under reducing conditions, antimonines are subject to biomethylation.
Arsenic, may be present in several oxidation states ranging from arsenate (As VI) arsines (As III) (Alloway, 1990; Hem, 1985)	Oxidized states sorb to soils under normal pH/Eh ranges, especially in the presence of Fe, Mn and Al oxides. More reduced states are more mobile.	Solubility in water of oxidized form is decreased by sorption to sediment.	Oxidized forms (arsenate, arsenite) are not volatile, but may adsorb to airborne particulates. Reduced forms (methyl arsines) are volatile.	Susceptible to biomethylation reactions over a wide range of pH conditions and under reducing conditions. Will be taken up by many plant species.
Barium, present as Ba(II) cation	Mobile in soil under normal pH/Eh conditions.	High solubility in normal pH/Eh waters.	Not volatile, may adsorb to airborne particles.	Metals may be reduced. Will be taken up by many plant species.
Beryllium (Alloway, 1990)	Will adsorb to soils at <u>normal pH conditions (>4)</u>. At pH values <4, become mobile.	Low solubility under normal pH condition (4 to 9) and will adsorb to sediments.	Not volatile, may adsorb to airborne particles.	Resistant to biodegradation, but will be taken up by many plant species.
Cadmium, present as Cd(II) cation (Alloway, 1990; Hem, 1985)	Will adsorb to soil in <u>normal pH ranges (>6)</u>, especially in the presence of Fe oxides and soil organic matter. However, can be displaced in competition with other more strongly sorbing metals such as Ba, Ca, Cr, and Zn.	Under normal pH conditions, is moderately sorbed to sediment. Will become soluble at low pH (<4).	Not volatile, may adsorb to airborne particulates.	Resistant to biodegradation, but will be taken up by plants in regions of low pH soils.
Chromium, present as Cr(VI) oxidation state as oxyanion (Alloway, 1990)	Mobile in soil at <u>normal pH ranges (4 to 9)</u>.	Soluble in water under normal pH condition. Under reducing conditions, will convert to Cr (III) and be sorbed to sediment.	Not volatile. May adsorb to airborne particles.	Likely to be reduced to Cr(III) in presence of organic matter.

TABLE 3-4

FATE AND TRANSPORT OF TEAD-N CHEMICALS OF POTENTIAL CONCERN
(2 of 7)

Contaminant	Soil	Water	Air	Biological Systems
Chromium, present as Cr(III) cation (Alloway, 1990)	Will be immobile and sorb to soils in normal pH ranges (>6), especially in the presence of Fe oxides and soil organic matter.	Under normal pH conditions, is moderately sorbed to sediment. Will become soluble at low pH (<4).	Not volatile. May adsorb to airborne particles.	Low bioavailability to plants.
Cobalt, present as Co(II) and Co(III) cations (Alloway, 1990)	Will readily adsorb to Mn and Fe oxides. Elevated organic content tends to make it exchangeable so that it is relatively easy to desorb.	Low solubility in normal pH conditions (6 to 9), is moderately sorbed to sediment and Fe and Mn oxides. Becomes increasingly soluble as pH decreases.	Not volatile. May adsorb to airborne particles.	Readily taken up by plants and animals.
Copper, typically present in Cu(II) cation (Alloway, 1990; Hem, 1985)	Will be retained in soils through exchange and specific adsorption mechanisms. High affinity for sorption to soluble organic and inorganic ligands may increase its mobility.	Relatively insoluble under normal pH/Eh conditions. Will undergo hydrolysis, complex formation, and or organic complex formation at elevated pH (>6).	Not volatile. May adsorb to airborne particles.	Readily taken up by plants and animals.
Cyanide	Will complex with iron and other cations and adsorb to soils. However, if complexing metals and/or clays are not present, can be mobile at elevated pH.	Moderate water solubility, but complexation and deposition will control availability.	May volatilize at low pH as HCN in shallow soil, where the ratio of water to surface area is high.	Will biodegrade in soil and groundwater under aerobic conditions.
Lead, present as Pb(II) cation (Alloway, 1990; Hem, 1985)	Immobile at normal pH ranges. Strong sorption to soil, especially in the presence of Fe, Mn and Al oxides.	Not soluble in water. Will become increasingly soluble at low pH.	Not volatile. May adsorb to airborne particles.	May be taken up by plants and animals.
Manganese, most likely as Mn(II) and Mn (IV) cations (Alloway, 1990; Hem, 1985)	Will be mobile in most soils due to exchangeability with other cations. Will form water-soluble organic and inorganic complexes.	Will readily form oxide precipitates under normal pH/Eh. Reducing environments and low pH increase solubility.	Not volatile. May adsorb to airborne particles.	May be taken up by plants and animals.
Nickel, present in Ni(II) cation (Alloway, 1990)	Will strongly adsorb to clays, Fe and Mn oxides, and organic matter. Formation of complexes with organic and inorganic ligands will increase mobility in soils.	Low water solubility at normal pH/Eh conditions, solubility increases with decreasing pH.	Not volatile. May adsorb to airborne particles.	May be taken up by plants and animals.
Selenium, mostly present as the oxyanions selenite (II) or selenate (IV) (Alloway, 1990; Hem, 1985)	Will be mobile in soil under normal pH/Eh conditions and becomes more mobile with increasing oxidation state. Will adsorb to soils by ligand exchange under low pH conditions.	Solubility in water of oxidized form (selenate) is highest and may be easily transported in groundwater. Under acidic or reduced conditions it is strongly attenuated by sorption to sediment.	Will volatilize by biomethylation. Methylation process tends to make selenate forms less mobile and toxic in soils.	Susceptible to biomethylation reactions, microbial induced oxidation reduction reactions form precipitates. Will be taken up by many plant species

TABLE 3-4

FATE AND TRANSPORT OF TEAD-N CHEMICALS OF POTENTIAL CONCERN
(3 of 7)

Contaminant	Soil	Water	Air	Biological Systems
Silver, present as Ag(I) cation (Alloway, 1990)	Immobile in most soil under normal pH/Eh conditions. Strongly adsorbed to clay and organic material, and will form several insoluble precipitates.	Most forms insoluble in water. Solubility will increase under low pH.	Not volatile. May adsorb to airborne particles.	May bioconcentrate in some plant species.
Thallium (Alloway, 1990)	Strongly resistant to leaching and is immobile in most soil. Will sorb to soil under reducing conditions especially in the presence of organic material. Under oxidizing conditions it will form precipitates with Mn and Fe.	Virtually insoluble under normal pH/Eh conditions. Will readily form oxide precipitates. Low pH increases solubility.	Not volatile. May adsorb to airborne particles.	Will readily be taken up by most plant species.
Zinc, present as Zn(II) cation (Alloway, 1990; Hem, 1985)	Moderately mobile in soil under normal pH/Eh conditions with mobility increasing with decreasing pH. Readily adsorbed by clays, carbonates, or hydrous oxides, but will desorb if high concentrations of other metals are present. Will form complexes with inorganic and organic ligands.	Some complexes have relatively high solubilities and will be mobile. Will hydrolyze at pH > 7.7 and the hydrolyzed species are strongly absorbed to sediment.	Not volatile. May adsorb to airborne particles.	Will readily be taken up by most plant species.

TABLE 3-4

FATE AND TRANSPORT OF TEAD-N CHEMICALS OF POTENTIAL CONCERN

Contaminant	Soil	Water	Air	Biological Systems
ORGANIC COMPOUNDS				
Explosives				
2,4,6-TNT (Layton and others, 1987; Howard, 1990)	Mobile in soil but may adsorb to soil particles and bind to humic materials in some environments. Susceptible to leaching. Not expected to hydrolyze. Vapor phase diffusion may be important in soil receiving limited infiltration (i.e. TEAD-N).	Moderate solubility, may weakly adsorb to sediment. Photolysis in surface water is a major fate mechanism. Not expected to undergo hydrolysis.	Will slowly volatilize from surface soil, and may adsorb to airborne particles. Vapor and airborne particles are subject to slow photolytic degradation.	May biodegrade under aerobic and anaerobic conditions but rates are slow. Bioconcentration is not significant.
2,4-DNT (Layton and others, 1987)	Mobile in soil. May undergo vapor phase diffusion in soil receiving limited infiltration.	Moderate solubility, and may weakly adsorb to sediments. Photolysis in surface water is a major fate mechanism. Not expected to undergo hydrolysis.	Will slowly volatilize from surface soil, and may adsorb to airborne particles. Subject to slow photolytic degradation.	May biodegrade under aerobic and anaerobic conditions but rates are even slower than for TNT. Bioconcentration is not significant.
2,6-DNT (Layton and others, 1987)	Mobile in soil, low to moderate adsorption to soil. May undergo vapor phase diffusion in soil receiving limited infiltration.	Moderate solubility, will not adsorb to sediments. Photolysis in surface water is a major fate mechanism. Not expected to undergo hydrolysis.	Will slowly volatilize from surface soil, and may adsorb to airborne particles. Subject to slow photolytic degradation.	May biodegrade under aerobic and anaerobic conditions but rates are slow (i.e., slower than for N). Bioconcentration is not significant.
1,3-DNB (Layton and others, 1987)	Mobile in soil, and susceptible to vapor phase diffusion. Not expected to adsorb to soil.	Moderate solubility, weakly adsorbs to sediments. Photolysis in surface water is a major fate mechanism. Not expected to undergo hydrolysis.	Will slowly volatilize from surface soil and may adsorb to airborne particles. Subject to slow photolytic degradation.	May biodegrade under aerobic and anaerobic conditions but rates are very slow. Bioconcentration is not significant.
1,3,5-TNB (Layton and others, 1987)	Mobile in soil. Not expected to adsorb to soil or volatilize. Will undergo only minimal hydrolysis.	Moderate solubility. Not likely to adsorb to sediments. Photolysis and hydrolysis are not important fate mechanisms.	Only minor volatilization from surface soil. May adsorb to airborne particles.	May biodegrade under aerobic and anaerobic conditions but rates are very slow. Bioconcentration is not significant.
RDX (Layton and others, 1987)	Moderate to high mobility in soil. Will not adsorb to soil.	Photolysis in surface water is a major fate mechanism. Hydrolysis is only significant in alkaline waters (pH>8). Will not adsorb to sediments.	Only very limited volatilization, but may adsorb to airborne particulates. Airborne particles are subject to photolysis.	May biodegrade under anaerobic conditions only. Bioconcentration is not significant.
HMX (Layton and others, 1987)	Moderate mobility in soil. Will weakly absorb to soil.	Photolysis in surface water is a major fate mechanism. Hydrolysis is only significant in alkaline waters (pH>8). Will weakly adsorb to sediments.	Only very limited volatilization, but may adsorb to airborne particulates. Airborne particles subject to photolysis.	May biodegrade under anaerobic conditions only; rates will be very slow (i.e. slower than for RDX). Bioconcentration is not significant

TABLE 3-4

FATE AND TRANSPORT OF TEAD-N CHEMICALS OF POTENTIAL CONCERN
(5 of 7)

Contaminant	Soil	Water	Air	Biological Systems
Tetryl (Layton and others, 1987)	Much less mobile than other explosives, moderate adsorption to soil and may bind to humic material. Subject to hydrolysis. Vapor phase diffusion may be important in soils receiving limited infiltration.	Moderate solubility, may adsorb to sediments. Photolysis in surface water is a major fate mechanism. Expected to undergo hydrolysis.	Will slowly volatilize from surface soil, and may adsorb to airborne particles. Vapor phase and airborne particles are subject to photolytic degradation.	May be susceptible to biodegradation but is not known.
Dioxins and Furans				
Tetrachlorodibenzo-p-dioxin (Based on similar chemical structures, other dioxin and furan compounds are expected to behave similarly)	Expected to strongly adsorb to soil and be resistant to leaching.	Insoluble. Expected to adsorb to sediments and not expected to hydrolyze or photolyze.	Not volatile. May adsorb to airborne particulates, with removal by wet and dry deposition.	Resistant to biodegradation. May bioconcentrate.
Pesticides and Herbicides				
Aldrine (Howard, 1990)	Immobile in soil, strongly adsorbs to soil and will resist leaching. Will transform quickly to dieldrin.	Virtually insoluble in water and will be sorbed and deposited into sediment. Residuals will volatilize from surface water.	Expected to volatilize from surface soil and water. May be sorbed to airborne particulates.	Will undergo biodegradation but rates are very slow; may bioconcentrate.
Chlordane (Howard, 1990)	Immobile in soil, strongly sorbed to soil and resists leaching.	Very low solubility in water, and will be sorbed and deposited onto sediment.	Expected to volatilize from surface soil and water. May be sorbed to airborne particulates.	Expected to be resistant to biodegradation; may bioconcentrate.
2,4-D (Howard, 1990)	Moderately mobile in soil, weakly adsorbed to soil, and leaching is significant in coarse gained soil, soil with low organic content, or elevated pH. Evaporation and hydrolysis are insignificant.	Moderately soluble in water, tends not to sorb to sediments especially at basic pH conditions. Will not volatilize in water nor is hydrolysis significant.	May be released directly to air or may be sorbed to airborne particles. Subject to photo-oxidation and rain out. Volatilization from surface soil and water is not significant.	Will readily biodegrade and is not expected to bioconcentrate.
Dieldrin (Howard, 1990)	Immobile in soil, strongly sorbed to soil, and resists leaching.	Very low solubility in water, and will be sorbed and deposited onto sediment.	Expected to volatilize slowly from surface soil and water or may be sorbed to airborne particulates. Very persistent but will slowly photorearrange to photodieldrin	Resistant to biodegradation and will bioconcentrate.
Endrin (Howard, 1990)	Immobile in soil, strongly sorbed to soils and resists leaching.	Very low solubility in water, and will be sorbed and deposited onto sediment. May photodegrade by photoisomerization in surface water.	Expected to volatilize slowly from surface soil and water or may be sorbed to airborne particulates. Very persistent but will slowly photorearrange to photodieldrin	Resistant to biodegradation and will bioconcentrate significantly in aquatic organisms.

TABLE 3-4

FATE AND TRANSPORT OF TEAD-N CHEMICALS OF POTENTIAL CONCERN
(6 of 7)

Contaminant	Soil	Water	Air	Biological Systems
Heptachlor (Howard, 1990)	Immobile in soil, strongly sorbed to soil and will resist leaching. Hydrolysis in most soil is expected to be significant.	Very low solubility in water. Will be sorbed and deposited onto sediment. Hydrolysis is expected to be significant.	Expected to volatilize from surface soil and water. May be sorbed to airborne particulates. Will react with photochemically generated hydroxyl radicals and ozone.	Will biodegrade slowly but is insignificant compared to hydrolysis. Will bioconcentrate.
Lindane (Howard, 1990)	Will slowly leach from soil and will also volatilize from surface soil. Hydrolysis is only significant under basic conditions.	Will diffuse in water rather than adsorb, and settle with sediment. Expected to volatilize from surface water.	Will volatilize from surface soil and water. May be sorbed to airborne particulates. Will react in vapor phase with photochemically generated hydroxyl radicals. Subject to gravitational settling and washout by rain.	Biodegradation is rapid under anaerobic conditions but slow under aerobic conditions. Bioconcentration is not significant.
p,p-DDD, p,p-DDE, p,p-DDT (Howard, 1990)	Immobile in soil, strongly sorbed to soil, and resist leaching.	Virtually insoluble in water and will be sorbed and be deposited onto sediment.	Expected to volatilize from surface soil and water. May be sorbed to airborne particulate. Subject to gravitational setting and wet/dry deposition.	Resistant to biodegradation and will bioconcentrate significantly.
PAHs (ATSDR, 1989; Howard, 1990)				
Low molecular weight PAHs Acenaphthene Acenaphthylene Anthracene Fluorene Phenanthrene	Moderate potential to be sorbed to soil. Sorption increases as organic content increases. In low organic soils, may leach.	Very low solubilities in water; will be sorbed and deposited onto sediment. May also photodegrade. Hydrolysis and oxidation are insignificant.	Volatilization is significant from surface soils and water. May adsorb to airborne particles. Will photodegrade or oxidize and be removed by wet and dry deposition.	Expected to biodegrade and/or bioconcentrate in aquatic organisms and plants.
Medium molecular weight PAHs Fluoranthene Pyrene	Immobile in soil, strongly sorbed to soil and resist leaching.	Virtually insoluble in water; will be sorbed and deposited onto sediment. May photodegrade from surface water. Hydrolysis and oxidation are insignificant.	Limited volatilization from surface soil and water. May adsorb to airborne particles. Will photodegrade or oxidize and be removed by wet and dry deposition.	Expected to biodegrade and/or bioconcentrate in aquatic organisms and plants.
High molecular weight PAHs Benzo(a)anthracene Benzo(a)pyrene Benzo(g,h,i)perylene Benzo(b)Fluoranthene Chrysene	Immobile in soil, strongly sorbed to soil and will resist leaching.	Virtually insoluble in water; will be sorbed and be deposited into sediment. May photodegrade. Hydrolysis and oxidation are insignificant.	Volatilization is insignificant from surface soil and water. May adsorb to airborne particles. Will photodegrade or oxidize and be removed by wet and dry deposition.	Expected to biodegrade and/or bioconcentrate in aquatic organisms and plants.

TABLE 3-4

FATE AND TRANSPORT OF TEAD-N CHEMICALS OF POTENTIAL CONCERN
(7 of 7)

Contaminant	Soil	Water	Air	Biological Systems
VOCs and other SVOCs				
Ethylbenzene (Howard, 1990)	Moderate sorption in most soils and will be susceptible to leaching. Will volatilize from shallow soil.	Moderate to low solubility in water and only weakly adsorb to sediment. Will not photolyze or hydrolyze.	Volatilizes and is persistent in atmosphere. May degrade by reaction with photochemically produced hydroxyl radicals.	Biodegradation is fairly slow but in acclimated systems may be accelerated. Resistant to anaerobic biodegradation. Does not bioconcentrate.
Hexachlorobenzene (Howard, 1990)	Tends to adsorb to soils and resists leaching.	Virtually in solubility in water and will strongly adsorb to sediment. Hydrolysis will not be significant.	Very limited volatilization from surface soils. May adsorb to airborne particles and be removed by wet and dry deposition.	Expected to be resistant biodegradation. Will bioconcentrate.
Naphthalene (Howard, 1990)	Low to moderate sorption to soil.	Moderate to low solubility in water and may adsorbed to sediment. Will undergo photolysis, and hydrolysis.	Low volatilization from surface soil and water. May degrade by reaction with photochemically produced hydroxyl radicals.	Biodegradation is fairly slow and tends to not bioconcentrate.
Phthalates Bis(2-ethylhexyl)phthalate Dimethylphthalate Di-n-butylphthalate 2-methylphthalate (Howard, 1990)	Tends to adsorb to soils and resistant to leaching (may leach in low-organic soils).	Low solubility in water will complex with humic material and will moderately sorb to sediment and other solids. May undergo hydrolysis and photolysis.	Limited volatilization from surface soil and water. May adsorb to airborne particles and be removed by wet and dry deposition. Vapor phase will photodegrade by reaction with hydroxyl radicals.	Expected to biodegrade slowly in soil and at a more rapid rate in water. Will bioconcentrate.
Toluene (Howard, 1990)	Moderate to high mobility in soil, susceptible to leaching. Highly volatile in shallow soil. Does not hydrolyze significantly.	Low to moderate solubility in water. Does not significantly hydrolyze, photolyze, or adsorb to sediment.	Volatilization from surface soil and water is a significant fate process. Degrades by reaction with photo-chemically produced hydroxyl radicals and will be washed out with rain. Not subject to direct photolysis.	Readily biodegradable in soil and water. Bioconcentration is not significant.
Xylenes (Howard, 1990)	Sorption to soil is moderate and will be susceptible to leaching, especially from soil with a low organic carbon content. Volatilization is significant from surface and shallow soil.	Low to moderate solubility in water. May adsorb to soil/sediment.	Volatilize readily and may degrade by reaction with photochemically produced hydroxyl radicals.	Biodegrades fairly rapidly in acclimated systems. Resistant to anaerobic biodegradation. Does not bioconcentrate.

3.2.5.16. Arsenic, hexavalent chromium, and selenium are mobile in aqueous solution under normal to high pH and oxidized conditions. As for other metals, mobility of these three metals will be inhibited by the presence of iron and aluminum oxides as well as high organic carbon content. The soil pH at TEAD-N is alkaline, and while alkaline conditions cause most metals in aqueous solution to precipitate and adsorb to soil particles, these conditions tend to facilitate the transport of these metal species.

3.2.5.17. Adsorption to airborne particles could be an important transport mechanism at TEAD-N because of the arid semi-desert climate and windy conditions. The air at SWMU 42 was monitored for metals adsorbed to airborne particles. The results of this monitoring are discussed in Section 13.0.

3.2.5.18. Cyanide is rapidly attenuated in soil or destroyed by oxidation/reduction reactions that occur from chemical and biological processes. Under aerobic conditions, cyanide is utilized efficiently by soil microorganisms (nitrification). Under anaerobic conditions, chemical complexion and adsorption in the presence of high iron and aluminum concentrations will immobilize cyanide. When free cyanide is exposed to the atmosphere in the presence of water, it may form HCN and become volatile.

3.2.5.19. Fate and Mobility of Organics. As will be discussed in Sections 5.0 through 15.0, only low concentrations (ppb range) of organic compounds were detected in the soils at each TEAD-N SWMU. The chemical compounds detected included explosives, dioxins, furans, pesticides, herbicides, VOCs, PAHs, and other SVOCs. The present concentrations of organics in soil beneath the various source areas have been influenced by reactions that these compounds undergo in soil including volatilization, adsorption and degradation by oxidation, reduction, and biodegradation. These reactions are controlled by the physical and chemical characteristics of the individual organic compounds, which are summarized on Table 3-2. The transformation of organic chemicals is determined by the individual structure and properties of these chemicals.

3.2.5.20. In general, fate and transport of organics can be summarized according to an approach by Ney (1990) that utilizes chemical characteristics. According to this approach, organic compounds that have low water solubilities (< 10 mg/L), low vapor pressures (< 1×10^{-6} mmHg), high log K_{OW} (> 3), and high K_{OC} (> 1000 mg/L) tend to adsorb to soil and be resistant to leaching (see Tables 3-2 and 3-3). These compounds also tend to bioconcentrate.

3.2.5.21. Conversely, organic compounds that have elevated water solubilities (> 1,000 mg/L), high vapor pressure (> 0.01 mmHg), low log K_{OW} (< 2.7), and low K_{OC} (< 100) tend to be mobile in soil and subject to leaching. These compounds tend not to bioconcentrate. Organic compounds that fall between these characteristic ranges may fall into either fate and transport category. In addition, organic compounds that have Henry's Law coefficient (> 10^{-3} atm-m^3/mol) volatilize readily while compounds that have coefficients between 10^{-3} and 10^{-5} atm-m^3/mol are more resistant to volatilization, and contaminants that have low coefficients (<10^{-5} atm-m^3/mol) tend not to volatilize.

3.2.6. Baseline Risk Assessment Methodology—Human Health

3.2.6.1. Introduction. This section discusses the potential of chemical releases at the TEAD-N Group A SWMUs to affect human health, and the general methodology used in assessing the potential risks. The details and conclusions of the risk assessments are SWMU-specific, and are included in Sections 5.0 through 15.0.

3.2.6.2. The Baseline Risk Assessment (BRA) evaluation consists of four primary steps:

- Selection of chemicals of potential concern
- Evaluation of exposure pathways
- Evaluation of toxicity
- Characterization of risks.

Selection of chemicals of potential concern (also known as hazard identification) is a process by which the chemicals responsible for most of the potential risk at the site are identified. The exposure pathway evaluation involves identifying pathways by which people may come in contact with chemical releases, and estimating the magnitude of the exposure for pathways where the exposure may be significant. The toxicity assessment is a summary of the available dose-response data for the chemicals of potential concern. The risk characterization evaluates the potential for health effects based on the potential exposure and the toxicity of the chemicals of potential concern. Major uncertainties are also identified in the risk characterization.

3.2.6.3. Selection of Chemicals of Potential Concern. The number of chemicals evaluated in the fate and transport discussions and the risk assessments was reduced from the list of all detected compounds by identifying those that are most likely to pose threats

to human health. The chemicals selected through this process will be referred to as chemicals of potential concern (COPCs). The selection of COPCs enables the risk assessor to evaluate a manageable number of chemicals that account for most of the risk from a given source area.

3.2.6.4. COPCs were selected for each SWMU. The following criteria were used to eliminate COPCs:

- Chemicals present at background concentrations were eliminated as COPCs. Whether or not a chemical is present at background concentrations was based on a threshold test, as described in Section 4.0. Metals detected above background concentrations in near-surface soil (0-12 feet bgs) but not in surface soil (0-0.5 feet bgs) were screened out as COPCs for scenarios involving only surface soil. A threshold test derives a concentration with which one has 95 percent confidence that no more than five percent of the background population is above this concentration. Therefore, where large numbers of samples have been collected, it can be expected that a small percentage of results will be above the threshold, but actually be representative of background. To be conservative, results above the threshold were assumed to result from releases at the SWMUs, but selected results have been given further discussion regarding their significance with respect to potential risks.

- Chemicals considered to be laboratory or sampling artifacts (e.g., methylene chloride, acetone, 2-butanone, and the common phthalate esters) were eliminated as COPCs, as outlined in EPA guidance (USEPA, 1994). These common sample contaminants are subject to the "ten-times rule", which is described in more detail in Appendix E. Also, the common phthalate compounds were considered "not detected" at concentrations less than 10 mg/kg, as explained in Section 3.2.4.4.

- Chemical detected in less than five percent of the samples from a SWMU were eliminated as COPCs. Chemicals present in less than five percent of the samples are not representative of overall site conditions. However, one or two samples with unusually high concentrations have been discussed qualitatively.

- Chemicals that are essential nutrients and present at concentrations well below levels associated with toxicity were eliminated as COPCs.

- Chemicals contributing less than one percent of the total risk based on a concentration-toxicity screen (described in the following paragraph) were eliminated as COPCs.

3.2.6.5. Concentration-Toxicity Screen. The concentration-toxicity screen is a ranked index based on the toxicity of a chemical and its maximum detected concentration. The purpose of the screen is to focus the assessment on the chemicals most likely to cause significant health effects. The concentration-toxicity screen was separately applied for carcinogenic and noncarcinogenic effects, and for different media where applicable. Only chemicals meeting the first four COPC selection criteria were included in the concentration-toxicity screen. For carcinogenic effects, an index was calculated as the sum of the products of the maximum concentrations of the detected chemicals (in a given matrix) and their oral slope factors:

$$\text{Carcinogenic Index} = \sum_i \text{Maximum Concentration of Chemical i x Oral Slope Factor of Chemical i}$$

Chemicals with the lowest indices that accounted for less than one percent of the total index as a group were eliminated as COPCs. However, it is necessary for all of the COPCs to equal 99 percent of the total index, so occasionally a chemical was retained even if its contribution was less than one percent. The same procedure was used for noncarcinogenic effects, except that the maximum concentration (in a given matrix) was divided by the oral reference dose:

$$\text{Noncarcinogenic Index} = \sum_i \text{Maximum Concentration of Chemical i / Oral Reference Dose of Chemical i}$$

Chemicals that have greater carcinogenic toxicity by the inhalation route of exposure than by oral exposure were not screened out by these indices.

3.2.6.6. In selecting the COPCs, data for certain individual compounds or classes of compounds were used in accordance with the following guidelines:

- Chromium was speciated as hexavalent or trivalent at SWMUs 1, 20, 21, and 42. Hexavalent chromium was not detected in samples from SWMU 1, but total chromium levels were not elevated either. To be conservative, the percentage of total chromium as hexavalent chromium found at SWMU 21 was applied to SWMU 1 (matrix interferences prevented a determination of this percentage at SWMUs 20 and 42). Where speciation data were unavailable and there was no reason to suspect that hexavalent chromium may be present at a SWMU based on past history of the site, chromium was assumed to be present in the trivalent oxidation state.

- Data from oil and grease, TPH-G (total petroleum hydrocarbons as gasoline), and TPH-D (total petroleum hydrocarbons as diesel) analyses were not used. The toxicity of these mixtures was represented by data from petroleum constituents including benzene, ethylbenzene, toluene, xylenes, and polyaromatic hydrocarbons.

3.2.6.7. Exposure Evaluation. The COPCs can be a hazard only if people have contact with them. Therefore, the first part of the exposure assessment is to determine the different methods by which people may come in contact with the COPCs. This involves identifying receptor populations, contaminant sources, and an exposure pathway between the sources and receptors. Methods of identifying receptors and exposure pathways are discussed in the following paragraphs; contaminant sources are discussed in Sections 5.0 through 15.0.

3.2.6.8. Both current and likely future receptors were evaluated. Typical current receptors include workers and, in some instances, site visitors or residents of nearby communities. Future receptors can include construction workers, future residents, and trespassers. Evaluation of future residents is required under UAC 315-101, even though none of these sites is expected to be used for residential purposes in the foreseeable future.

3.2.6.9. An exposure pathway describes a mechanism by which receptors can be exposed to chemical constituents present at or originating from a site. An exposure pathway consists of four necessary elements:

- A source and mechanism of chemical release to the environment
- An environmental transport medium for the released chemical

- A point of potential human contact with the contaminated medium
- A potential human exposure route at the point of exposure.

3.2.6.10. All four elements must exist for an exposure pathway to be considered complete and for exposure to occur. Incomplete exposure pathways do not result in actual exposure and were not included in the risk assessment. When evaluating a pathway for completeness, both current and potential future land uses were considered, along with behavior patterns, activity levels, and locations of activities for each identified receptor population.

3.2.6.11. Pathways that are (or are likely to become) complete were also evaluated for the potential magnitude of exposure. In addition, pathways associated with potential future residents were evaluated to provide a benchmark and to comply with Utah Administrative Code Rule 315-101. Pathways that were judged minor were not evaluated in the quantitative risk assessment. Pathways were judged minor for two types of reasons:

- A pathway led to less exposure than another pathway, and was no more likely to be completed. For example, exposure of occasional SWMU visitors was an insignificant pathway at SWMUs where workers were currently present on a regular basis.

- A pathway was known to lead to levels of exposure not associated with unacceptable risks. For example, the magnitude of concentrations of volatile organic compounds in soil at less than 1 part per million was not considered sufficient to generate elevated risks in outdoor air.

3.2.6.12. General exposure routes include ingestion, inhalation, and dermal pathways. Ingestion of chemicals in soil/sediment occurs as a result of getting soil/sediment on one's hands, followed by incidentally ingesting the soil/sediment when eating food or smoking cigarettes. Inhalation exposure to soil/sediment contaminants generally refers to inhalation of wind-generated dust. Dermal exposure results from chemicals in soil/sediment being absorbed through the skin. For most receptors, exposure involves only those chemicals in the top six inches of soil; in some areas where the soil is disturbed on a regular basis (such as in SWMU 1 where demolitions are carried out) the exposure was assumed to involve the upper 2 feet of soil. However, construction workers may be exposed to soil up to 12 feet deep, depending on the depth of the foundation. For

groundwater and surface water, ingestion exposure can occur if the water is used as drinking water, and dermal exposure can occur if the water is used for bathing or swimming. The inhalation exposure route for water applies only to chemicals that volatilize; volatile chemicals were not detected in groundwater, and consequently, the inhalation pathway was not considered complete and was not evaluated.

3.2.6.13. Exposure was quantified for those pathways that are (or may become) complete and were judged as being potentially significant. The quantification of exposure requires estimates of exposure parameters (such as the frequency and duration of exposure) and of exposure point concentrations.

3.2.6.14. All available chemical data from the Phase I and Phase II RFI investigations were used to estimate exposure point concentrations. Chemical data used to estimate potential health risks complied with criteria in EPA's Guidance for Data Usability in Risk Assessment (USEPA, 1992b). In addition, dust monitoring data (collected as part of the health and safety program for the RFI investigations) was used for estimating potential dust levels. The lesser of the 95 percent upper confidence limit (UCL) of the mean and the maximum concentration was used in estimating exposure point concentrations for COPCs. Concentrations corresponding to the 95 percent UCL of the arithmetic mean were calculated for each SWMU using the following equation:

$$\text{95 percent UCL} = \overline{X} + \frac{st}{\sqrt{n}}$$

where:

	$\overline{X}$	=	arithmetic mean of site data
	s	=	standard deviation of site data
	t	=	value from the t-distribution table corresponding to n-1 degrees of freedom
	n	=	number of data points averaged.

All data from a SWMU that met data quality objectives were included in the 95 percent UCL calculation. The 95 percent UCL equation assumes that data are normally distributed. The combination of using an upper bound estimate of the mean (i.e., the UCL) and a sampling strategy that targeted locations likely to be the most contaminated, makes it unlikely that the true mean is higher than the calculated mean.

3.2.6.15. Replicate soil samples from different depth intervals were treated as separate samples when estimating the UCL. Duplicate samples (composited from the same depth interval or the same well) were averaged. If a chemical was not detected, half the detection limit was used in estimating the UCL unless the detection limit was greater than the maximum concentration detected. For those rare cases, the non-detect sample was dropped from the database.

3.2.6.16. Exposure Equations. The reasonable maximum exposure (RME) of potential receptors to COPCs was quantitatively estimated for pathways judged complete (or potentially complete) and significant. The RME is the highest exposure that is reasonably expected to occur at a site and is estimated by combining 95th percentile values for one or more exposure parameters. For exposure scenarios where the exceedence of benchmark risk levels (see Sections 3.2.6.36. and 3.2.6.37.) is potentially due to this conservative approach, the exposure also was estimated using average values for all of the exposure parameters. This approach is termed a central tendency exposure (CTE) evaluation. The CTE evaluation was performed to obtain added perspective on the potential risks at the site. In keeping with a conservative approach, the RME estimate will typically be given greater weight than a CTE evaluation. However, the CTE evaluation in combination with qualitative analysis can develop a weight of evidence that should be given serious consideration when making risk management decisions. The following paragraphs present the general equations used to estimate exposure. The exposure parameters that were used in the equations for the RME and CTE evaluations are listed in Appendix K.

3.2.6.17. The inhalation exposure dose from contaminants in dust was estimated using the following equation:

$$\text{Inhalation Exposure Dose (mg/kg-day)} = \frac{\text{CS x CF x CD x IR x EF x ED}}{\text{BW x AT}}$$

where:

CS	=	Contaminant concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
CD	=	Concentration of respirable dust in air from the SWMU (mg/m^3)
IR	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged; days)

The concentration of respirable dust from a SWMU was modeled for estimating exposure to residents living near the Depot. The model assumptions and parameters are included in Appendix K.

3.2.6.18. The ingestion exposure dose from contaminants in soil and food (from uptake from soil) was estimated using the following equation:

$$\text{Ingestion Exposure Dose (mg/kg-day)} = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

where:

CS	=	Contaminant concentration in soil or food (mg/kg)
IR	=	Ingestion rate (mg soil/day)
CF	=	Conversion factor (10^{-6} kg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged; days)

3.2.6.19. Intake from dermal contact with contaminated soil was estimated as follows:

$$\text{Dermal Exposure Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS	=	Contaminant concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface area exposed (cm^2)
AF	=	Adherence factor of soil (mg/m2)
ABS	=	Skin absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged; days)

3.2.6.20. Ingestion of groundwater or surface water was estimated using the following equation:

$$\text{Ground or Surface Water Ingestion Exposure Dose (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where:

CW	=	Contaminant concentration in water (mg/l)
IR	=	Ingestion rate (liters/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged; days)

As will be explained in the text accompanying the individual SWMUs, inhalation exposures were not quantified for surface water or groundwater.

3.2.6.21. Intake from dermal contact with contaminated groundwater or surface water was estimated using the following equation:

Ground or Surface Water Dermal Exposure Dose (mg/kg-day) =

$$\frac{CW \times SA \times ET \times EF \times ED \times PC}{BW \times AT}$$

CW	=	Contaminant concentration in water (mg/l)
SA	=	Skin surface area exposed (cm^2)
ET	=	Exposure time (hours)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
PC	=	Permeability constant (cm/hr)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged; days)

3.2.6.22. Toxicity Evaluation. The toxicity evaluation in this section is largely complete, and the discussions for the individual SWMUs draw upon this information. The toxicity evaluation considers three primary criteria: the potential for a chemical to cause cancer, the potential for a chemical to cause non-cancerous effects (including affects on reproduction), and the concentration of lead in blood. For carcinogens, it is assumed that no threshold exists and any dose may induce cancer. For noncarcinogens, it

is assumed that there is a dose below which no adverse health effects occur (i.e., a threshold dose). For lead, it is assumed that there are no effects (or more precisely, there are effects in only an extremely small percentage of the population) when lead concentrations in blood are below a threshold.

3.2.6.23. The cancer slope factor (SF) quantitatively expresses the carcinogenic hazard of a chemical. The slope factor is expressed in units of $(mg/kg/day)^{-1}$ and represents the cancer risk per unit daily intake of the chemical. The SF represents the upper 95 percent confidence interval of the slope of the dose-response curve. The 95 percent confidence interval value assures a safety factor to protect the most sensitive receptors. The product of the SF and the exposure dose is an estimate of the risk of developing cancer from exposure to the compound of interest. The cancer risks from multiple COCs are assumed to be additive. However, the evidence for carcinogenicity of different compounds is highly variable and the effects of chemicals having different target organs and/or mechanisms of action may not actually be additive.

3.2.6.24. The overall weight of evidence for the carcinogenicity of a compound can be assessed using USEPA's classification scheme, as presented in Table 3-5. This weight-of-evidence classification has been used in interpreting the significance of a calculated risk. The weight-of-evidence determination is often made from animal data. While positive animal cancer test data suggest that people may also develop cancer, this may not always be true. There are also sources of uncertainty in the computation of a slope factor. In the hazard assessment of noncarcinogenic effects, positive animal data may be more successful in predicting effects that may be manifested in humans. For most toxicity studies, there are several equally valid methods of interpreting the data, and data normally are interpreted in a conservative manner.

3.2.6.25. The reference dose (RfD) quantitatively expresses the potential hazard for toxicological effects other than cancer. The RfD is expressed in units of mg/kg/day and represents a daily intake of contaminant per kilogram of body weight that is not sufficient to cause adverse health effects. Exposure doses that are above the RfD could potentially cause adverse health effects. Reference doses are established for chronic exposure (durations of at least seven years), and subchronic exposure (durations of two weeks to seven years).

TABLE 3-5

EPA WEIGHT-OF-EVIDENCE CATEGORIES FOR POTENTIAL CARCINOGENS

EPA Category	Description	Evidence
Group A	Human Carcinogen	Sufficient evidence from epidemiology studies to support a causal association between exposure and human cancer.
Group B1	Probable Human Carcinogen	Limited evidence of carcinogenicity in humans from epidemiology studies.
Group B2	Probable Human Carcinogen	Sufficient evidence of carcinogenicity in animals, inadequate evidence of carcinogenicity in humans.
Group C	Possible Human Carcinogen	Limited evidence of carcinogenicity in animals; no data for humans.
Group D	Not Classified	Inadequate evidence of carcinogenicity in animals.
Group E	No Evidence of Carcinogenicity	No evidence of carcinogenicity in at least two adequate animal tests or in both epidemiology and animal studies.

Source: USEPA, 1989b

3.2.6.26. The RfD incorporates an uncertainty factor that generally lowers the threshold dose. This uncertainty factor is intended to account for factors such as the uncertainty of extrapolating animal studies to humans; the existence of subpopulations within the human population that are unusually sensitive to a chemical; and the quality of the laboratory study and database from which the toxicity information is derived. Chemical-specific toxicological data do not account for the potential effects of chemical mixtures; this limitation is further discussed in the uncertainty section contained within each SWMU.

3.2.6.27. The primary sources of toxicity values include the following:

- The Integrated Risk Information System (IRIS)

- USEPA's Health Effects Assessment Summary Tables (HEAST), 1994.

Separate RfDs and SFs are available for inhalation and oral exposure. Oral toxicity values have been modified to derive dermal toxicity values since dermal exposure estimates are based on the amount of a chemical reaching the bloodstream. Oral toxicity values (which are based on total intake into the body), modified by the fraction absorbed into the bloodstream, form a reasonable basis for dermal toxicity values. Oral absorption data have been compiled from a number of different sources. Inhalation toxicity values were not available for all compounds. For organic compounds, inhalation toxicity is thought to be no greater than oral toxicity. When oral RfDs and SFs for organic COPCs were used as surrogates for inhalation values, there was never a hazard index greater than one or a cancer risk greater than 1×10^{-6} for the inhalation pathway. Conversely, metals can be much more toxic by inhalation than ingestion. Metals without inhalation toxicity values are addressed on a SWMU-specific basis in Sections 5.0 to 15.0. Reference doses and slope factors for the COPCs are summarized in Tables 3-6 and 3-7, respectively.

3.2.6.28. For lead, the USEPA Uptake/Biokinetic Model (IEUBK Model; USEPA, 1991a) was used to estimate blood lead levels in children to age six. For adults, the model in the State of California Department of Toxic Substances Control (DTSC) Supplemental Guidance for Human Health Multimedia Risk Assessments (DTSC, 1992) was used because the IEUBK model is for children only. The DTSC model was used for exposure pathways where children under the age of six would not be receptors, such as construction work. A recent directive employs a residential screening level of 400 mg/kg for lead (USEPA, 1994). In instances where the blood lead models are inappropriate, this

TABLE 3-6

SUMMARY OF CARCINOGENIC TOXICITY INFORMATION
FOR CHEMICALS OF POTENTIAL CONCERN

Compound	Oral Slope Factor (mg/kg/day)-1	Oral Carcinogen Class	Oral Absorption (percent)	Oral Target Organ	Inhalation Slope Factor (mg/kg/day)-1	Inhalation Carcinogen Class	Inhalation Target Organ
VOCs							
Toluene	--	D	99	--	--	D	--
BNAEs							
Benzo(a)Pyrene	7.3E+00	B2	50(2)	stomach	--	B2	stomach
Benzo(g,h,i)Perylene	--	D	50(2)	--	--	D	--
Bis(2-ethylhexyl)phthalate	1.4E-02	B2	25(2)		--	B2	
Fluoranthene	--	D	50(2)	--	--	D	--
Hexachlorobenzene	1.6E+00	B2	NA	liver	1.6E+00	B2	liver
4-Methylphenol	--	C	80	--	--	--	--
Phenanthrene	--	D	50(2)	--	--	D	--
Pyrene	--	D	50(2)	--	--	D	--
Pesticides and PCBs							
2,4-D	--	--	50	--	--	--	--
DDD	--	D	50	--	--	D	--
p,p'-DDE	3.4E-01	B2	90(9)	liver,thyroid	--	B2	liver,thyroid
p,p'-DDT	3.4E-01	B2	50(9)	liver	3.4E-01	B2	liver
Endrin	--	D	50(17)	--	--	D	--
Dioxins/Furans							
2,3,7,8-TCDD	1.5E+05	B2	87(17)	respiratory system, liver	1.5E+05	B2	respiratory system, liver
Explosives							
1,3,5-Trinitrobenzene	--	--	80(18)	--	--	--	--
1,3-Dinitrobenzene	--	D	80(18)	--	--	D	--
2,4,6-Trinitrotoluene	3.0E-02	C	80(18)	urinary bladder	--	C	urinary bladder
Cyclonite (RDX)	1.1E-01	C	30(19)	liver	--	C	liver
2,4-Dinitrotoluene	6.8E-01	B2	75(18)	kidney	--	B2	kidney
2,6-Dinitrotoluene	6.8E-01	B2	75(18)	kidney	--	B2	kidney
HMX	--	D	15(9)	--	--	D	--
Inorganic							
Antimony	--	--	1(10)	--	--	--	--
Arsenic	1.8E+00	A	100(2)	skin	1.5E+01	A	lung
Barium	--	--	5(9)	--	--	--	--
Beryllium	4.3E+00	B2	5	lung	8.4E+00	B2	lung
Cadmium	--	D	7(9)	--	6.3E+00	B1	lung
Chromium, Hexavalent	--	D	11(9)	--	4.1E+01	A	lung
Chromium, Trivalent	--	--	4(9)	--	--	--	--
Cyanide	--	D	1	--	--	D	--
Lead	--	B2	--	kidney	--	B2	kidney
Manganese	--	D	3(7)	--	--	D	--
Mercury	--	D	15(9)	--	--	D	--
Nickel	--	--	10(9)	--	--	--	
Selenium	--	D	97(9)	--	--	D	--
Silver	--	D	10(13)	--	--	D	--
Thallium chloride	--	D	100(14)	--	--	D	--
Zinc	--	D	30(9)	--	--	D	--

VOCs Volatile organic compounds
BNAEs Base, neutral, and acid extractables

-- Not available on IRIS or HEAST
mg/kg/day milligram per kilogram per day
A Human carcinogen
B2 Probable human carcinogen
C Possible human carcinogen
D Not classified

Oral Absorption footnotes:

1 USEPA Technical Support Document 1990, based on lead uptake model
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17 Owen, B.A., 1990. Literature Derived Absorption Coefficient, for 39 Chemicals via Oral and Inhalation Routes of Exposure. Regulatory Toxicoloty and Pharmacology 11:237-252
18 Layton, D. et al., 1987. Conventional Weapons Demilitarization: A Health and Environmen Effects Database Assessment
19 Based on comparison to HMX

TABLE 3-7

SUMMARY OF NONCARCINOGENIC TOXICITY INFORMATION FOR CHEMICALS OF POTENTIAL CONCERN

	Oral						Inhalation				
	Chronic		Subchronic				Chronic		Subchronic		
Compound	RfD (mg/kg/day)	Uncertainty Factor	RfD (mg/kg/day)	Uncertainty Factor	Oral Absorption (percent)	Target Organ	RfD (mg/kg/day)	Uncertainty Factor	RfD (mg/kg/day)	Uncertainty Factor	Target Organ
VOCs											
Toluene	2.0E-01	1,000	2.00E+00	100	99	liver, kidney	1.40E-01	300	1.40E-01	300	CNS, respiratory system
BNAEs											
Benzo(a)Pyrene	--	--	--	--	50[2]	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	2.0E-02	1,000	--	--	25[2]	liver	--	--	--	--	--
Fluoranthene	4.0E-02	3,000	4.0E-01	300	50[2]	kidney, liver, blood	--	--	--	--	--
Hexachlorobenzene	8.0E-04	100	--	--	NA	liver	--	--	--	--	--
4-Methylphenol	5.0E-03	1000	5.0E-03	1,000	80	CNS, respiratory system, whole body	--	--	--	--	--
Phenanthrene	--	--	--	--	50[2]	--	--	--	--	--	--
Pyrene	3.0E-02	3,000	3.0E-01	300	50[2]	kidney	--	--	--	--	--
Pesticides and PCBs											
2,4-D	1.0E-02	100	1.0E-02	100	50	blood, liver, kidney	--	--	--	--	--
DDD	--	--	--	--	50	liver	--	--	--	--	--
p,p'-DDE	--	--	--	--	90[9]	liver	--	--	--	--	--
p,p'-DDT	5.0E-04	100	5.0E-04	100	50[9]	liver	--	--	--	--	--
Dieldrin	5.0E-05	100	5.0E-05	100	50[17]	liver	--	--	--	--	--
Endrin	3.0E-04	100	3.0E-04	100	50[17]	CNS, liver	--	--	--	--	--
Dioxins/Furans											
2,3,7,8-TCDD	--	--	--	--	87[17]	immune system	--	--	--	--	--
Explosives											
1,3,5-Trinitrobenzene	5.0E-05	10,000	5.0E-04	1,000	80[18]	spleen	--	--	--	--	--
1,3-Dinitrobenzene	1.0E-04	3,000	1.0E-03	100	80[18]	spleen	--	--	--	--	--
2,4,6-Trinitrotoluene	5.0E-04	1,000	5.0E-04	1,000	80[18]	liver	--	--	--	--	--
Cyclonite (RDX)	3.0E-03	100	3.0E-03	100	30[19]	prostate	--	--	--	--	--
2,4-Dinitrotoluene	2.0E-03	100	2.0E-03	100	75[18]	CNS, erythrocytes, biliary tract	--	--	--	--	--
2,6-Dinitrotoluene	1.0E-03	3,000	1.0E-02	300	75[18]	whole body, CNS, blood, bile duct, kidney	--	--	--	--	--
HMX	5.0E-02	1,000	--	--	15[9]	blood,liver	--	--	--	--	--

VOCs Volatile organic compounds
BNAEs Base, neutral, and acid extractables
CNS Central nervous system
RfD Reference dose
-- Not available on IRIS or HEAST
mg/kg/day milligram per kilogram per day

Oral Absorption footnotes:

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TABLE 3-7

SUMMARY OF NONCARCINOGENIC TOXICITY INFORMATION
FOR CHEMICALS OF POTENTIAL CONCERN
(CONTINUED)

	Oral						Inhalation				
	Chronic		Subchronic				Chronic		Subchronic		
Compound	RfD (mg/kg/day)	Uncertainty Factor	RfD (mg/kg/day)	Uncertainty Factor	Oral Absorption (percent)	Target Organ	RfD (mg/kg/day)	Uncertainty Factor	RfD (mg/kg/day)	Uncertainty Factor	Target Organ
Inorganic											
Antimony	4.0E-04	1,000	4.0E-04	1,000	1(10)	whole body, blood	--	--	--	--	--
Arsenic	3.0E-04	3	3.0E-04	3	100(2)	skin	--	--	--	--	--
Barium	7.0E-02	3	7.0E-02	3	5(9)	cardiovascular system	1.0E-04	1,000	1.0E-03	100	fetus
Beryllium	5.0E-03	100	5.0E-03	100	5	none observed	--	--	--	--	--
Cadmium (water)	5.0E-04	10	--	--	7(9)	kidney	--	--	--	--	--
Cadmium (food)	1.0E-03	10	--	--	7(9)	kidney	--	--	--	--	--
Chromium, Hexavalent	5.0E-03	500	2.0E-02	100	11(9)	none observed	--	--	--	--	--
Chromium, Trivalent	1.0E+00	1,000	1.0E+00	1,000	4(9)	none observed	--	--	--	--	--
Cyanide	2.0E-02	500	2.0E-02	500	1	whole body, thyroid, nerve	--	--	--	--	--
Lead	--	--	--	--	--	CNS	--	--	--	--	--
Manganese (water)	5.0E-03	1	5.0E-03	1	3(7)	CNS	1.4E-05	1,000	--	--	CNS
Manganese (food)	1.4E-01	1	1.4E-01	1	3(7)	CNS	1.4E-05	1,000	--	--	CNS
Mercury	3.0E-04	1,000	3.0E-04	1,000	15(9)	kidney	8.6E-05	30	8.6E-05	30	nervous system
Nickel	2.0E-02	300	2.0E-02	300	10(9)	whole body, major organs	--	--	--	--	--
Selenium	5.0E-03	3	5.0E-03	3	97(9)	whole body	--	--	--	--	--
Silver	5.0E-03	3	5.0E-03	3	10(13)	skin	--	--	--	--	--
Thallium chloride	8.0E-05	3,000	8.0E-04	300	100(14)	liver, blood, hair	--	--	--	--	--
Vanadium	7.0E-03	100	7.0E-03	100	1(10)	--	--	--	--	--	--
Zinc	3.0E-01	3	3.0E-01	3	30(9)	blood	--	--	--	--	--

VOCs Volatile organic compounds
BNAEs Base, neutral, and acid extractables
CNS Central nervous system
RfD Reference dose
-- Not available on IRIS or HEAST
mg/kg/day milligram per kilogram per day

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19 Based on comparison to HMX

screening level has been employed in the overall discussion. This guidance states that 400 mg/kg is not a cleanup level, but a benchmark to trigger further investigation.

3.2.6.29. The blood-lead estimates are fundamentally different than the exposure estimates for other compounds in that average exposure parameters are used rather than RME. The blood-lead estimates therefore are not as inherently conservative as cancer and hazard index estimates. However, inaccuracy in pharmacokinetic parameters may still lead to overestimates or underestimates in calculated blood lead values.

3.2.6.30. Uncertainties in the blood-lead level are lower for children than for adults. As a sensitive population, children have been the subject of greater study, allowing better calibration of the IEUBK model. The DTSC model used to predict adult blood lead levels has not been reviewed by USEPA, but makes the following assumptions that are conservative when compared to the IEUBK model for children:

- The bioavailability of lead is assumed to be 44 percent, compared to 30 percent in the IEUBK model.
- The lead concentration in water is assumed to be 15 µg/l compared to approximately 4 µg/l in the IEUBK model.
- The lead concentration in air is assumed to be 0.18 $\mu g/m^3$ plus a site-specific contribution, while the IEUBK model assumes 0.1 $\mu g/m^3$ outside, and 0.03 $\mu g/m^3$ indoors.
- Lead uptake is assumed to be directly proportional to lead intake, whereas the IEUBK model assumes that when lead concentrations in the gut become sufficiently large, the fraction of lead absorbed decreases.

The proportion of lead entering the bloodstream could not be compared to the IEUBK model because the adsorption for adults and children is different. If the bioavailabilities used for different exposure routes are underestimates, then adult blood lead levels could be underestimated in spite of the conservativeness of the elements listed above. The DTSC model, as a whole, is conservative for children as demonstrated by the fact that child blood lead levels were predicted to be higher in the DTSC model than in the IEUBK model. In addition, the IEUBK model appears to not infrequently overpredict blood levels when compared with actual blood lead data.

3.2.6.31. For dioxins/furans, the EPA toxicity equivalency factors (TEFs; USEPA, 1987) were used to evaluate toxicity. The concept of TEFs is that 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD) has the greatest carcinogenicity of all dioxin and furan congeners and the toxicity of other congeners can be expressed as a proportion of 2,3,7,8-TCDD toxicity. The concentration of congeners other than 2,3,7,8-TCDD were multiplied by the congener-specific TEF, which was always less than 1. The adjusted concentrations were summed and the slope factor for 2,3,7,8-TCDD was used to estimate the carcinogenic toxicity from the total dioxins and furans.

3.2.6.32. Carcinogenic polyaromatic hydrocarbons (PAHs) were evaluated using potency equivalency factors (PEFs; USEPA, 1993a). The concept of a PEF is analogous to the TEFs for dioxins/furans, but the values have had less review within EPA. For noncarcinogenic effects, the reference dose for pyrene was used as a surrogate for PAHs without a compound-specific reference dose.

3.2.6.33. In addition to the quantitative information provided in this section, the toxicity of the COPCs can be described qualitatively. The different toxicological aspects of the COPCs are profiled in Appendix L.

3.2.6.34. Risk Characterization. For carcinogens, risk estimates represent the incremental probability that an individual will develop cancer over a lifetime as a result of exposure to the COPCs (USEPA, 1989c). These risks are termed excess lifetime cancer risks and are calculated using the following equation:

$$\text{Excess Lifetime Cancer Risk (Risk)} = \text{LDI} \times \text{SF}$$

where:

LDI	=	Lifetime daily intake (mg/kg/day)
SF	=	Slope factor $(\text{mg/kg/day})^{-1}$

3.2.6.35. A cancer risk is expressed as a probability, such as one additional cancer in an exposed population of one million (which is expressed as 1×10^{-6} or 1E-06). The lifetime daily intake is the exposure dose averaged over a 70-year lifetime. This is in keeping with the concept that there are no threshold doses for carcinogens, and that total lifetime exposure contributes more to risk than the average dose during shorter-term exposure events. Ingestion and inhalation risks are calculated separately because compounds often have different slope factors for these routes of exposure.

3.2.6.36. The magnitude of cancer risk relative to Superfund site remediation goals in the National Contingency Plan ranges from 10^{-4} (one-in-ten-thousand) to 10^{-6} (one-in-one-million) depending on the site, proposed usage, and chemicals of concern (USEPA, 1989c). Within this range, the level of risk is considered to be acceptable at a specific site is a risk management decision and is decided on a case-specific basis. It is generally accepted that risks above this range require attention. The one-in-a-million level of risk is often referred to as the *de minimis* level of risk; risks calculated below this range would not require attention. The 1x 10^{-6} risk level does not equate to an actual cancer incidence of one-in-a-million. For substances that may cause cancer, the risk assessment process uses animal data to predict the probability of humans developing cancer over a 70-year lifetime. The numbers are given as upper bounds; the real risk is expected to be less. The one-in-a-million risk level is a theoretical prediction that no more than one person out of a million lifetimes would contract cancer due to the environmental exposure. By the way of comparison, the average person in the U.S. incurs a background risk of cancer (from all causes) of about one chance in four (0.25). Adding a risk of 0.000001 to a background risk of 0.25 is of little significance to any single individual. These small risk levels may be of concern only if the exposed population includes many millions of people.

3.2.6.37. The potential for individuals to experience effects other than cancer was evaluated by comparing the exposure dose to the reference dose. This comparison takes the form of a ratio termed the Hazard Index (HI), which is calculated by dividing the exposure dose by the reference dose:

$$\text{Hazard Index} = \frac{\text{ED}}{\text{RfD}}$$

where: ED = Exposure dose
RfD = Reference dose.

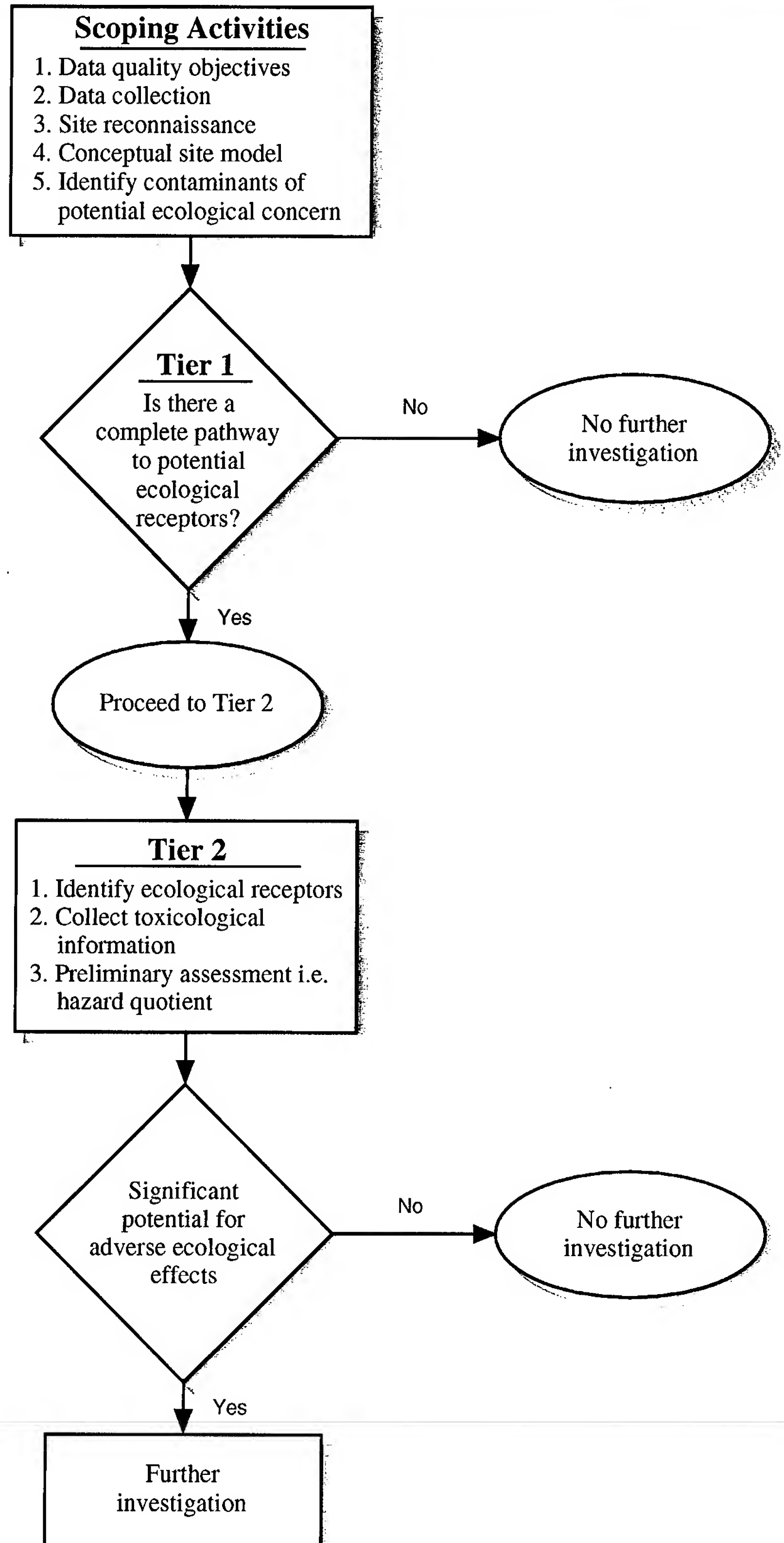
ED and RfD are expressed in the same units (mg/kg/day) and represent a chronic or subchronic exposure period, depending on the duration of exposure. If the hazard index is less than or equal to 1.0, then no chronic health effects are expected. If the hazard index is greater than 1.0, adverse health risks are possible. There is some latitude in these conclusions, depending on the potential for underestimating or overestimating the exposure dose.

3.2.6.38. Reduced intelligence quotients and growth rates have been reported for children with blood lead concentrations above 10 µg/dl. Soil lead concentrations leading to blood lead levels less than 10 µg/dl are presumed to have little potential to cause adverse effects. Pregnant women can transfer lead to a fetus, although lead levels will be higher in the mother. Blood lead concentrations over 10 µg/dl in a fetus have been associated with premature birth, reduced birth weight, and decreased intelligence quotient in the infant. High blood pressure has been associated with middle aged men whose blood lead levels were over 15 µg/dl. Based on the effects that may occur in adult men and in a fetus, a range between 10 and 15 µg/dl in less than 5 percent of adults was adopted as a benchmark with which to evaluate potential adverse effects from lead.

3.2.7. Assessment Methodology-Ecological Risk

3.2.7.1. The objective of the ecological assessment at the SWMU sites within the TEAD-N facility is to qualitatively determine the potential adverse effects caused by the chemicals of potential ecological concern (COPECs) detected at the site. The findings of the SWMU-specific ecological assessments presented in this report will be incorporated in the site-wide ecological assessment being prepared by RUST E & I. The assessment is conducted using the guidance developed by the USEPA which includes the Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual (USEPA, 1989b), ECO Update - Framework for Ecological Risk Assessment (USEPA, 1992a), Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference. (USEPA, 1989), and Ecological Risk Assessment (Suter, 1993).

3.2.7.2. The ecological assessments integrate the sampling data from the RI activities with the information collected from the biological surveys in order to perform a tiered evaluation of the sites. The results of Tier 1 (Scoping Activity) determine whether a site may be proposed for No Further Investigation or progresses to a Tier 2 evaluation within this report. If the analytical data indicate that there is no complete exposure pathway between the COPECs and the potential ecological receptors, then the site is proposed for No Further Investigation. Alternatively, if the collected information indicates that there is a potential for a complete exposure pathway between the COPECs and habitats where ecological receptors are present, then the potential adverse impact due to exposure of ecological receptors to a COPEC is evaluated in Tier 2. The decision tree for the ecological assessment at the SWMU sites in the TEAD-N facility is illustrated in Figure 3-1. The SWMU-specific discussions describe the results of the tiered evaluations for each site.



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TEAD-N RFI—GROUP A SWMUs
DECISION TREE
ECOLOGICAL RISK ASSESSMENT
FIGURE 3-1

3.2.7.3. The ecological risk assessment framework within each tier consists of three stages. The level of effort required for each stage increases as the evaluation progresses from Tier 1 to Tier 2. The first stage is the problem formulation and identifies the COPECs, the media of concern, the distribution of the habitats at the facility, and the ecological receptors at habitats of concern. This leads to the formulation of a conceptual site model that describes the relationship between the stressors at the site, the species potentially at risk, and the potential adverse effects of the COPECs. In this report, the Tier 1 evaluation initially identifies ecological communities or groups rather than specific species or organisms. The second stage is the analysis stage. In the Tier 1 analysis, potentially complete pathways are determined and species are selected that may have a high potential for exposure to the COPECs via each pathway. The third stage of Tier 1 is a risk characterization that identifies sites that are of potential ecological concern versus sites of no potential ecological concern. The criteria for the selection of these sites were described above.

3.2.7.4. In Tier 2, the problem formulation (stage 1) identifies specific ecological receptors and specific habitats of concern based on the distribution of the COPECs. The analysis stage (stage 2) includes the evaluation of the complete exposure pathways to a selected subset of potential receptors that are called the indicator species. If the selection of the target species is done correctly, it allows one to extrapolate effects from a small subset of species to those of a larger group of similar species, and potentially to the ecological community as a whole. In Tier 2, the potential for adverse impacts of the COPECs on selected ecological receptors (stage 3) is based on ecological toxicity values and qualitative factors such as the area of habitat affected and the frequency with which COPECs are above the toxicity values.

3.2.7.5. Problem Formulation. The description of the physical, geological, and climatological setting of the TEAD-N facility is discussed in Section 2.0 of this report. Previous field surveys of the TEAD-N facility provided information on the plant and animal species that occur or that may potentially occur at the facility, and this information is presented in Section 2.6. Flora and/or fauna that were observed to be specific to a certain SWMU site are indicated in the SWMU-specific discussions (Sections 5.0 to 15.0).

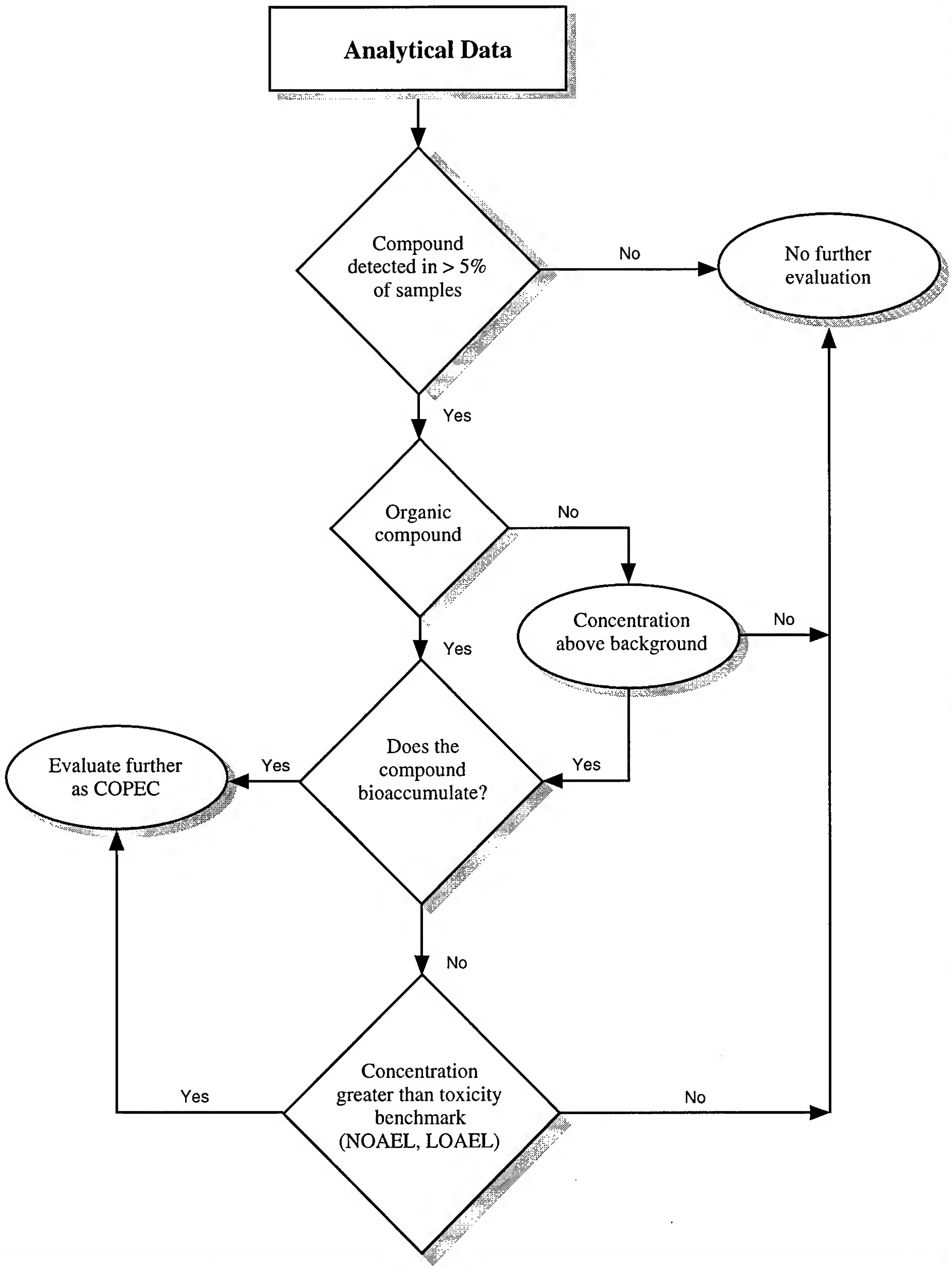
3.2.7.6. The scope of the ecological assessment focused on eight SWMUs at the TEAD-N facility. The same types of habitats occur throughout the facility and there is no

discrete delineation of specific types of vegetation from one SWMU to another. Thus, each SWMU is identified by the range and soil type to which it belongs. The range and soil types are taken from a soil survey for Tooele County (USSCS, 1991). The range describes the climax vegetation expected to occur due to the combined influence of environmental factors characteristic for the area. Most SWMUs presently display some level of physical disturbance from open burning and open detonation (OB/OD) activities, removal of topsoil and vegetation as a result of building construction, or disturbances from off-road vehicular traffic.

3.2.7.7. The ecological assessment includes two vegetation descriptions: (1) the expected climax vegetation for the range site, and (2) the dominant vegetation observed within the SWMU boundary during a site visit. Some climax species are present within the disturbed SWMU boundaries and illustrate successional stages. The major plant species that are expected or were observed at TEAD-N are presented in Table 2-2.

3.2.7.8. Wildlife expected or observed at each SWMU is also discussed. Table 2-3 summarizes the wildlife observed or expected at TEAD-N. In addition, those species which have federal or Utah sensitive species status are noted in this table.

3.2.7.9. Identification of Chemicals of Potential Ecological Concerns. One of the elements in the Problem Formulation stage is the identification of the chemical stressors. The COPECs are the chemical stressors that are identified and evaluated in this ecological risk assessment. The field investigations at each of the SWMUs generated a list of detected chemicals in the different environmental media. The COPECs from the surface soil, subsurface soil, surface water, and sediment are identified by a step-wise process which is illustrated by the decision tree in Figure 3-2. The initial step is a comparison of the maximum detected concentrations of each detected inorganic analyte to its background value. An inorganic analyte with a maximum detected concentration that exceeds its background value is identified as a COPEC in the Tier 1 evaluation and is proposed for further evaluation in Tier 2. In Tier 2, the COPECs are compared to the typical soil concentrations that are not known to have any adverse effects on experimental animals, or to the typical range in United States soils, or to NOAEL/LOAEL values. Chemicals whose concentration in the media approach or exceed these benchmarks are identified as the COPECs.



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TEAD-N RFI—GROUP A SWMUs

SELECTION OF CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN

FIGURE 3-2

3.2.7.10. Identification of Ecological Receptors. The different species (flora and fauna) that occur or may potentially occur at each SWMU site are collated from available literature and were validated by field surveys (RUST, 1994). The categories of receptors for TEAD-N would be expected to include: terrestrial vegetation, mammals, birds, and reptiles. For each receptor, the assessment will include a characterization in the form of a species profile. These profiles include, but are not limited to, descriptions of trophic status, feeding type, food preferences, prey, predators, migratory habits, breeding habits, likely habitats, and any other relevant ecological and physiological characteristics and taxonomic relationships.

3.2.7.11. The habitat assessment identifies ecological communities that are located at the point of exposure. Stressors that result from management practices may also be considered in terms of how habitats may be affected or depleted. For example, the removal of native desert soils that results from the physical disturbance associated with site operations (i.e., clearing, traffic paths) decreases the soil's water-holding capacity. Thus, plants adapted to drought conditions such as weed species, dominate areas within the SWMU boundaries.

3.2.7.12. The species used in the ecological risk assessment are called the indicator species. The candidate indicator species selected for the ecological assessment of the SWMUs at the TEAD-N facility represent a reasonable cross section of the major functional and structural components of the ecosystem. Consideration is given to the inclusion of species or groups that represent different trophic levels, a variety of feeding types, and potential habitats. These species represent receptors that potentially have the greatest direct exposure to the soil contaminants. The selection is based on relative abundance and ecological importance within the potential habitats, relative sensitivity to the COPECs, relative mobility, local feeding ranges, and the availability of biological values (i.e., body weights, food and water ingestion rates, and measurement endpoints). In order to provide a risk management perspective, an evaluation of potential risk for ecological receptors via possible exposures is presented. Since small mammals whose home range is contained within an area equal to or less than the area of the site are likely to receive the greatest exposure to site chemicals, indicator species from this group, (i.e., mouse, rat, kangaroo rat, rabbit) are selected for quantification of risk. The potential impact of the COPECs on protected, threatened, endangered, or species of special concern are also considered in Tier 1 and Tier 2. However, these species cannot be selected as indicator species if the ecological assessment requires investigation beyond

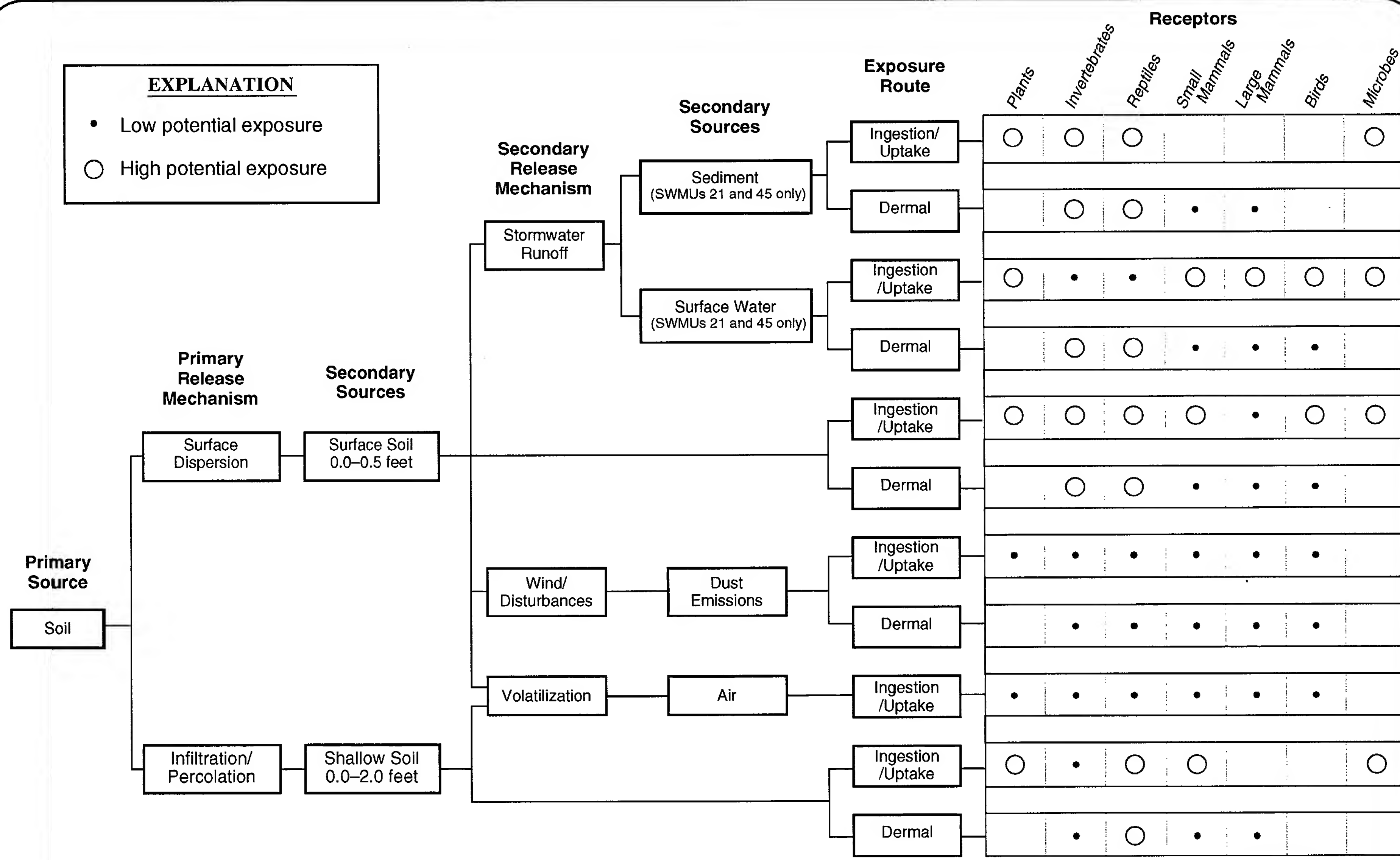
Tier 2 because they must be protected as individuals (i.e., these receptors cannot be sampled for tissue analysis).

3.2.7.13. Identification of Media of Concern. Potentially contaminated media at TEAD-N consist of soil, sediment, surface water, groundwater, air, and biota. However, not all potentially contaminated media at a site are accessible to all receptors. The Tier 1 evaluation identifies the media of concern for each SWMU. Media of concern are defined as media that are contaminated, and that ecological receptors (both terrestrial and aquatic) can contact.

3.2.7.14. In the TEAD-N facility, the terrestrial ecosystem is predominant. The environmental transport media primarily consists of soil; surface water and sediment are considered to a much lesser extent. Potential exposure routes from contaminated air to ecological receptors include inhalation of volatilized chemicals in open air or burrows, absorption through plant surfaces, inhalation of soil particulates, and ingestion of airborne dusts which are trapped by oral saliva or nasal mucous. However, these pathways are considered relatively insignificant compared to the ingestion pathway. Contaminants in outdoor air will typically be diluted. Because the detected concentrations of VOCs are less than 1 mg/kg, the contribution of the air pathway is not considered to be of significant magnitude. The air pathway, therefore, is not evaluated in the quantitative ecological risk assessment.

3.2.7.15. Conceptual Site Model. The conceptual model presented in Figure 3-3 illustrates the release mechanisms and the potential migration pathways or exposure routes for contaminants. The conceptual site model also illustrates whether ecological receptors are exposed to contaminants.

3.2.7.16. The Analysis Stage. The analysis stage for ecological risk assessment evaluates the potential ecological effects and the exposure to the COPECs. A preliminary evaluation of the fate and transport characteristics of the COPECs provides information regarding whether a chemical may be transported to the point of exposure. The pathway analysis identifies the complete exposure pathways. Most impacts from direct exposure occur to organisms at the lowest level of the food-chain. Indirect exposure affects species in the higher tropic levels due to bioaccumulation and biomagnification. The conceptual site model presented in Figure 3-3 illustrates the relationship between an identified chemical stressor, the potential ecological receptor, and the exposure pathway



TEAD-N-GROUP A SWMUs
CONCEPTUAL SITE MODEL
ECOLOGICAL RISK ASSESSMENT
FIGURE 3-3

MONTGOMERY WATSON

that leads to a direct exposure scenario. Figure 3-4 is a simplified diagram of the food web that identifies receptors that may be exposed to contaminants indirectly at each trophic level.

3.2.7.17. Section 2.6 describes the vegetation and wildlife that may be present or inhabit the TEAD-N facility. The conspicuous native species throughout the facility are big sagebrush, Utah juniper, sand dropseed, needle- and threadgrass, and rubber rabbitbrush. Recreationally important species (e.g., mule deer and game birds) and endangered or threatened species (e.g., peregrine falcon) are potentially exposed populations at the sites. However, the exposure of these species is not considered of significant magnitude due to the lack of vegetation in and around the sites and due to the characteristic and expected behaviors of the various special-designation species.

3.2.7.18. Potentially exposed populations at the site would most likely include small burrowing rodents, other small rodents, and reptiles. Rodents are omnivorous and would be expected to be exposed to contaminants through ingestion of soil, ingestion of contaminated food sources, and inhalation and dermal contact as a result of soil burrowing activities. The ground squirrel, kangaroo rat, etc., may be potentially exposed due to their burrowing activities which are similar to those of rodents. These species are representative of actual inhabitants of the area and are likely environmental receptors. The desert kangaroo rat may inhabit areas of sagebrush communities. They spend days in deep burrows in sandy areas or sand dunes to maintain stable temperature and humidity. They have multiple entrances and exits from their dens to escape predators. They forage on mesquite, tumbleweed, Russian thistle, sunflower, sandbur, and grasses. Seeds and grasses are their primary forage. Their typical forage range would not exceed one square mile, and activity is at night or early morning. Their primary predators include owls, foxes, coyotes, and rattlesnakes.

3.2.7.19. The burrowing owl is a small, long-legged, diurnal perching owl that traditionally resides in colonies adjacent to ground squirrels or prairie dogs. They inhabit the sagebrush areas and open spaces. They nest in abandoned rodent burrows and live in colonies. The burrowing owls is active at various times of the day and night but have been observed to be most active in the late afternoon, evening, and at night (Thomsen, 1971). The owl's mean home range has been observed to be 2 acres, but varies from 0.1 to 4 acres (Thomsen, 1971). Burrowing owl feed on a variety of mammals, birds, plants, and insects. The owl consumes more than its weight in prey species each day, including the meadow vole. Predators of the burrowing owl include falcons, hawks, harriers,

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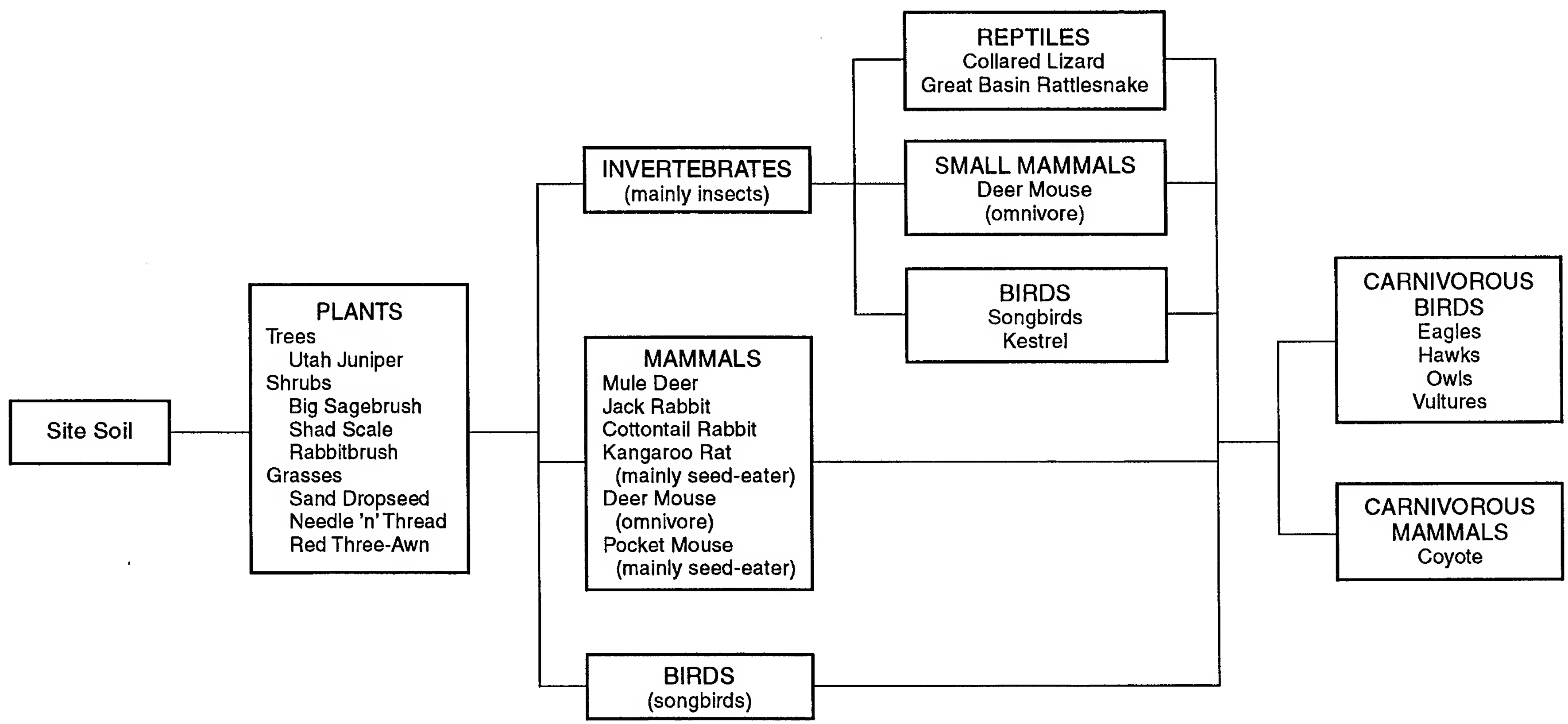


MONTGOMERY WATSON

TEAD-N–GROUP A SWMUs
GENERALIZED FOOD-WEB
FIGURE 3-4

golden eagles, foxes, and coyotes. The burrowing owl normally live among rodent populations and are a higher order consumer in the food chain than the kangaroo rat.

3.2.7.20. The black-tailed hare (Lepus californicus) is a possible receptor at the TEAD-N facility. The habitat of the hare is herbaceous and desert shrub areas, and the annual grassland and ruderal areas provide habitat within the study area. The black-tailed hare is strictly herbivorous and generally eat any vegetation up to 20 inches above the ground, but prefers grasses and forbs (Zeiner, 1990). The hare uses shrubs for cover and does not burrow. The hare is most active during daylight and dim light (Zeiner, 1990). Its home range averages 45 acres. Likely predators in the site include the barn owl, and the northern harrier.

3.2.7.21. The exposure pathways likely to be of concern to terrestrial populations include incidental ingestion of soil and dermal contact with soil. Water and wind may disperse chemicals throughout the environment. However, given the small amount of annual precipitation at the site, runoff from the TEAD-N is unlikely. Groundwater does not provide a source of surface water except for SWMU 21; therefore, it is not considered as a complete pathway for the other SWMUs.

3.2.7.22. Bird populations could be exposed to contaminants through direct contact with or ingestion of contaminated soils or ingestion of contaminated food sources. Most of the bird species at the TEAD-N site would be expected to be transient; these areas represent only a small portion of their total foraging and breeding habitat.

3.2.7.23. Dermal exposure is not anticipated to result in significant exposures for large or small mammals and birds. Aside from the protective effect of the feathers, most birds spend a portion of their time perched in trees or bushes and are therefore relatively less exposed to chemicals in the soil. Invertebrates and reptiles may also be exposed to soil contaminants via the dermal pathway.

3.2.7.24. Where sediment is present (SWMUs 21 and 45), plants may be exposed to contaminants by root uptake. Invertebrates and reptiles may be exposed to contaminants in the sediment both by ingestion and dermal exposure. The significance of the exposure pathway is dependent on the chemical's bioavailability and bioconcentration potential.

3.2.7.25. Where surface water is present (SWMUs 21 and 45), plants may be exposed to dissolved contaminants by root uptake. Terrestrial invertebrates and reptiles likely have

no significant exposure to surface water. Aquatic invertebrates and reptiles that prefer moist or water habitats would be primarily exposed through the skin. Small and large mammals, as well as birds, may be exposed to dissolved and particulate contaminants in the water primarily by drinking. For the receptors in the immediate vicinity as well as mammals and birds with a high degree of mobility that are farther away, the surface water at SWMUs 21 and 45 may be the primary source of water.

3.2.7.26. Groundwater exposure routes to ecological receptors depend on the availability of groundwater to plants and animals. Potential exposure routes from contaminated groundwater to ecological receptors may include uptake of contaminants by the root systems of plants and translocation to shoots. However, depths to groundwater are several hundred feet, and consequently this is not expected to be a complete pathway.

3.2.7.27. A plant or animal that has been exposed to chemicals may accumulate the compound in their tissues and transfer the chemical to consumers and predators through the food-chain pathway. The potential exposure routes from contaminated biota to ecological receptors may include ingestion of contaminated plant or animal species. Compounds that have a log K_{OW} greater than 3.0 (USEPA Region VIII, 1994) or a bioconcentration factor (BCF) greater than two (Rust E&I, 1993) may have the potential to affect higher order consumers in the food web. For second and third order consumers (predators), food-web pathways are likely to be the primary route of exposure at the SWMUs.

3.2.7.28. Exposure Point Concentrations. The exposure point concentration is measured at or near the presumed point of contact with receptors. In the Tier 2 assessment, the estimate of the exposure point concentration and dose is conducted for each target species and for each COPEC for all relevant exposure routes. For exposure routes wherein the target species has direct contact with contaminated media (i.e., ingestion, dermal exposure), the lesser of the 95% UCL of the arithmetic mean or the maximum detected concentration is calculated as the exposure point concentration (USEPA, 1989c). The concentrations of the COPECs in the environmental media are compared to selected biological endpoints. The endpoints are primarily derived from ecotoxicological data such as the NOAEL, the LOAEL, or typical soil concentrations that did not exhibit any toxic effects (or exhibited minimal effects) in animal studies. In cases where both NOAEL values and soil concentration levels that are ecologically-protective are available, the soil concentration values (which are more direct comparisons) are used as the endpoints. The uncertainty in using this approach is considered in the risk

evaluation. Where data for a specific species or endpoint are unavailable, the other toxicity data (LOAELs) are used. It has been recommended that LOAEL data be divided by a safety factor of 5 for comparison to NOAEL data (Lewis, S.C. and others, 1990). In cases where toxicity data are not available for the indicator species, the literature toxicity value should be divided by a safety factor of 5 when extrapolating between species within the same genus; the toxicity value is divided by a safety factor of 10 when extrapolating between species of the same family; and a safety factor of 20 should be applied when extrapolating between species of the same order (Suter, 1993). It is recognized that this is a simplistic approach that has uncertainties associated with it; thus, the use of safety factors is applied only for screening purposes.

3.2.7.29. Indirect exposure to receptors may occur through the ingestion of contaminated food or prey. If a COPEC does not bioaccumulate, then it will be conservatively assumed that ingested prey have body burdens equivalent to the concentration detected in the contaminated medium. This conservative approach is applied as a screening tool in order to ensure a comprehensive evaluation of the COPECs. A COPEC that does not have an adverse ecological impact through this screening assumption will, most assuredly, be a COPEC of no ecological concern. On the other hand, a COPEC that is estimated to have an ecological effect because of the screening exposure assumptions will be evaluated further by using more species-specific exposure assumptions. If COPECs have bioaccumulation potential, then BAFs will be incorporated into the assessment of the COPECs that need further evaluation after the Tier 2 ecological assessment. For terrestrial vertebrates, if the log K_{OW} of the chemical is greater than 3.0, the COPEC is considered to have the potential to significantly bioaccumulate from food (or ingested soil) into lipids (USEPA Region VIII, 1994). If a COPEC has a log K_{OW} less than 3.0, it will be evaluated based on its concentration alone.

3.2.7.30. For some exposure routes, such as ingestion, where the toxicological data is reported as a dose, the exposure point concentrations are converted into an estimated daily intake or dose (mg chemical/kg of body weight/day). For other exposure routes, such as dermal exposure, the exposure point concentration calculated from the medium of concern is directly compared to the available ecotoxicological data.

3.2.7.31. The detected concentration levels and the distribution of the detected chemicals are the components analyzed in order to estimate the concentration that will ultimately be made available to the selected ecological receptors. The average body weights and the ingestion rates of the indicator species are values cited in the Recommendations for and

Documentation of Biological Values for Use in Risk Assessment (USEPA, 1988b) and Wildlife Exposure Factors Handbook (USEPA, 1993b).

3.2.7.32. Risk Characterization. The risk characterization is the final stage in an ecological risk assessment and the level of effort increases with each tier. The Tier 1 risk evaluation identifies the sites that do not show complete exposure pathways between the COPECs and the ecological receptors. The Tier 2 evaluation is described in the following paragraphs.

3.2.7.33. The potential for adverse ecological impact in Tier 2 is expressed as the ecological toxicity quotient (ETQ). The ETQ is the ratio of the dose or the 95 percent UCL of the chemical concentration in the soil to the NOAEL (whether an experimental value or a calculated value from another endpoint). The effective concentration may be the eco-protective concentration in soil, the NOAEL, or the LOAEL that has been compared to a NOAEL value by dividing with the safety factor of five. Information on the toxicity and potency of COPECs is obtained from published eco-toxicological literature, applicable ecotoxicological databases, and regulatory guidelines. The ecological quotient was estimated in either one of two ways. When animal studies were available, the site concentrations of the chemicals were compared to the typical soil concentrations that had been demonstrated to have no adverse effect on the experimental species. If no soil data from animal studies are available, the estimated ETQ was expressed as the ratio of the dose to the NOAEL or the adjusted LOAEL. A COPEC with an ETQ of 1.0 or less is not expected to have adverse ecological effects and will not be proposed for further investigation as a contaminant of ecological concern (COEC). A COPEC with an ETQ of more than 1.0 is considered a COEC. However, the ETQ estimation is not the only criterion for proposing a site for further evaluation because of the inherent uncertainties in the methodology and other uncertainties that will be discussed in Sec. 3.2.7.31. Other factors such as comparison of site concentration levels with published literature values and/or regulatory standards and criteria, as well as direct observations of conditions in the field, will all provide an overall weight of evidence concerning the nature of the ecological risk present at the sites. The evaluation of all of these factors will support the recommendation that a site be proposed for further quantitative assessment.

3.2.7.34. Uncertainty. Each stage of the ecological risk assessment has accompanying uncertainties that affect the overall assessment. The generation of the conceptual model is based on certain assumptions about the impacted habitats, the species they support, and

the potential exposure scenarios. The selection of the indicator species is partly based on field surveys, but largely on information collected from the literature.

3.2.7.35. There are also uncertainties due to certain data gaps. Limited quantitative information is available detailing which ecological resources are exposed to site releases. Although an animal species list is available for the TEAD-N facility, a habitat description relative to the sites has not been fully prepared. The number of subsurface soil and sediment samples collected from the SWMU sites may not be adequate enough to accurately define the extent of the contamination that may impact resident species at the SWMU sites.

3.2.7.36. There are also uncertainties in the toxicity and exposure assessments. The exposure pathways, bioconcentration factors, bioaccumulation factors, and the lack of chemical-specific or species-specific data all contribute to the inherent uncertainty in the risk assessment. Site-specific toxicity studies on terrestrial wildlife at the sites have not been performed to correlate with contamination by the COPECs. No site-specific information on biotransformation or bioaccumulation potential is available. Site-specific measurements of site chemicals present in the diet and tissues of flora and fauna have not been collected, thus quantitative evaluation of the exposure and risk to ecological resources is hampered. Potential phytoxicity to indigenous species is limited, and thus it is uncertain whether soil concentrations prevent the establishment of plant life.

3.2.7.37. The characterization of ecological effects also has uncertainties due to species extrapolation that may be assumed if there are no species-specific toxicological data or chronic NOAEL/NOAEC or LOAEL/LOAEC values available on the selected ecological receptor.

3.2.7.38. To reduce this uncertainty, species-specific testing may be eventually proposed with the species collected at the site or with surrogate species. However, this type of analysis is recommended only if the overall weight of evidence, as previously stated, indicate that the ecological risk has to be quantitated further by tissue sampling. When multiple toxicity values for the same endpoint in a given species are listed in databases or in the literature, the lowest value found is like to be overly conservative (DeSesso, J., 1994). Among the subtle adverse effects that may not be discovered by traditional toxicity testing are seemingly minor physiological and/or behavioral changes that may result in reduced fecundity, altered rates of maturation of individuals leading to a decrease in the number of adults available for mating, any changes that may affect the

ability of the species in question to compete for food or to avoid predation, or avoidance of certain contaminants resulting in emigration.

3.2.7.39. The Tier 2 assessment at TEAD-N is assessing the potential risk to ecological receptors from exposure to single COECs. However, mixtures of chemicals may act antagonistically, additively or synergistically. Evaluating a site-specific mixture can also reduce the uncertainty associated with assessing the risk due to exposure to elevated COECs.

3.2.8. Evaluation of Explosive Risk

3.2.8.1. One component of the risk assessment is to provide an evaluation of the potential for explosive risk as each SWMU where potentially unexploded ordnance items are or could be present. UXB International, Inc. was tasked with providing these evaluations during the RFI. While supporting the field activities UXB identified unexploded ordnance items and uncased explosives. These items were moved out of the work sites, and TEAD-N OB/OD Range Control personnel were notified of their location for final disposition. Based on the results of UXB's field program support determinations of explosive risks were prepared for this Phase II RFI. A copy of UXB's report is included as Appendix N. A summary of these discussions are presented in the individual SWMU discussions (Sections 5.0 through 15.0).

3.2.8.2. Risk Determination Methodology—Explosive Risk. At each Group A SWMU where UXO-support was required (SWMUs 1, 1b, 1c, 1d, and 42), a summary of potentially explosive items encountered was prepared. The determination of explosive risk is based on an evaluation of the potential for personal injury should any of these potentially explosive items ignite or detonate. The list, a discussion of potential receptors, exposure routes, and several recommendations to mitigate the risks are presented in the SWMU-specific discussions.

3.2.9. Criteria for Corrective Action Recommendations

3.2.9.1. Section 17.0 of this RFI report contains a summary of the conclusions and recommendations for each of the Group A Suspected Releases SWMUs. In accordance with the objectives of the Phase II RFI, there are three general response actions that can be made for each SWMU. These include:

- No further action
- An interim remedial action (IRA)
- A corrective measures study (CMS)

This subsection describes the general criteria used to select the appropriate response action for each SWMU.

3.2.9.2. In accordance with recent changes to the State of Utah's administrative code (UAC, 1994), the need for and extent of environmental cleanups can be based on risks to human and environmental health according to current land-use scenarios. This regulation states that cleanup standards can be derived for a site where there has been a release through a risk assessment. The risk assessment must evaluate the site assuming residential land use. If the cancer risk is less than one in a million and the hazard index is less than one under residential land use, then no further action may be proposed for the site. An additional requirement for no further action at a site is that the site must not act as a future source of groundwater contamination.

3.2.9.3. If the site is not eligible for no further action as determined by the residential scenario, the risk assessment may also evaluate the site under actual current or projected future land use. If the cancer risk is less than one in ten thousand and the hazard index is less than one under current or projected future land use, then a site management plan must be developed under a corrective measures study including such activities as monitoring, site security, and/or post-closure care. The site management plan may also contain procedures for corrective action. If the cancer risk is greater than one in ten thousand or the hazard index is greater than one under current or projected future land use, then the corrective measures study must require that corrective action be undertaken. While the rule requires that an ecological assessment be conducted, it does not indicate how the results of that assessment are intertwined with the decision of whether no action is acceptable, or if a site management plan or corrective action is necessary.

3.2.9.4. For this RFI, the remedial action objectives apply to pathways that are complete or that can be expected to be completed, and are as follows:

- A cancer risk between one in one million and one in ten thousand

- A hazard index less than one

- No significant ecological effects, as defined in Section 3.2.7.

- No significant threats to groundwater

- Where applicable, a maximum blood-lead level between 10 and 15 micrograms per deciliter in less than one percent of the exposed population.

Where the remedial action objectives incorporate a range of values, qualitative factors are used to evaluate whether a remedial action objective towards the low or the high end of the range is most appropriate. Such factors include whether the pathway is complete or is only a potentially complete pathway, and whether the risk estimates are considered accurate or are likely to be large overestimates.

3.2.9.5. As indicated above, an IRA can also be considered for a SWMU. In this RFI, an IRA will be considered if any of the following apply to a *current* receptor:

- The cancer risk is greater than 1 in 10,000
- The hazard index exceeds 1
- The blood-lead level exceeds 15 micrograms per deciliter
- A known ecological risk exists
- A SWMU is acting as an ongoing source of groundwater contamination.

The exception to the above guidelines is that if the environmental contaminants are the same chemicals a worker is exposed to while carrying out the duties of his or her job, an interim remedial action will be taken only if concentrations exceed occupational levels.

4.0 BACKGROUND CONDITIONS AND DATA REPORTING LIMIT EVALUATION

4.0.0.1. This section is composed of three subsections that individually discuss background soil conditions at TEAD-N, upgradient groundwater quality at the Stormwater Discharge Area (SWMU 45), and the data reporting limit differences between USAEC contract reporting limits (CRLs) and USEPA SW-846 practical quantitation limits (PQLs). Background soil conditions are evaluated in terms of concentrations of metals in carefully selected background soil samples. These concentrations represent natural abundance concentrations and will be compared with the results of soil sample analyses at individual SWMUs where metals are suspected contaminants. Because of the different soil types at the various SWMUs at TEAD-N (see Figure 2-5), the analysis of background conditions includes a statistical determination of upper bound values for each soil type. The upgradient groundwater quality section describes the field program and sampling results of monitoring well installation and sampling at SWMU 45. The Corrective Action Permit for TEAD-N specifies USEPA SW-846 PQLs for reporting analytical data (USEPA, 1989). Because the USACE CRLs are not always consistent with the PQLs, this section discusses the efforts to meet the PQL reporting requirement and the success of this effort.

4.1. BACKGROUND SOIL CONDITIONS

4.1.1. Soil Sampling Programs

4.1.1.1. Surface and shallow background soil data collected during both phases of the RFI were combined to develop the following discussions of background conditions. A total of 36 surface and shallow subsurface soil samples were collected from background soil sampling locations. These locations were sited across TEAD-N to represent each of the major soil types present on the Depot. Background samples were collected at locations that were considered to be unaffected by the physical operations at the SWMU sites, but near enough to sample similar soil types. To evaluate shallow soil conditions, samples were collected from the surface and 2 to 3-foot depths at each location (see Figure 2-5). All background samples were submitted for analysis of total metals. Background samples collected during the Phase I investigation were also submitted for analysis of selected anions.

4.1.2. Analysis of Background Soils Data

4.1.2.1. TEAD-N Soil Types. Representative concentrations of the naturally occurring metals in the shallow soils at TEAD-N ("background" concentrations) were needed to compare with SWMU-specific analytical results. Based on a U.S. Soil Conservation Service (USSCS) map of the TEAD-N area, four primary soil types were initially identified for the Group A SWMUs: Abela, Berent, Hiko Peak, and Medburn. For discussion purposes, these four soil types were given following the geographic-lithologic descriptors:

- Abela - Eastern coarse-grained soil
- Berent - Western fine-grained soil
- Hiko Peak - Western coarse-grained soil
- Medburn - Eastern fine-grained soil.

4.1.2.2. The USSCS does not use constituent concentrations as a soil classification criterion. Rather, classifications are based on physical properties and may not reflect differences in soil chemistry. To investigate if the differences in soil types correlated with differences in soil chemistry, the results of metals analyses of background samples were compiled by soil type and the concentrations of individual metals for each soil type were compared statistically. Initial assumptions were that the chemistry for each soil type was unique and that the chemistry could vary between the surface (0.0-0.5 feet bgs) and shallow subsurface (0.5 to 3.0 feet bgs). Tables 4-1 through 4-4 list the background analytical results for metals for each of the principal soil types. Appendix P tabulates these data by sample ID.

4.1.2.3. Comparisons of Soil Types. Sample populations from each soil type were compared statistically with the Students t-test for unpaired means using the computer program Statview (Statview, 1992). The Students t-test was selected as the most appropriate statistical test. Differences with the two-tailed probability of a Type I error (false positive) of 0.05 or less between sample populations were considered statistically significant. If an analyte was detected less than four times in a sample population, no statistical comparison was made. Also, if an analyte was not detected in both sample populations being compared, no difference between the soils could be inferred. If no differences between the concentrations of the metals was observed, then the sample populations from the two soil types can be merged because the populations are not statistically different.

TABLE 4-1

ABELA SOILS
(EASTERN TEAD-N, COARSE-GRAINED)
BACKGROUND ANALYTICAL RESULTS

Analyte (µg/g)	Sample ID: Date Collected: Depth (ft):	SB-BK-009 11/2/93 0.0	SB-BK-009 11/2/93 3.0	SB-BK-010 11/2/93 0.0	SB-BK-010 11/2/93 3.0
Aluminum		3200	2440	7230	8260
Antimony		<7.14	<7.14	<7.14	<7.14
Arsenic		7.81	5.89	13.0	5.57
Barium		40.7	39.0	76.4	102
Beryllium		<0.5	<0.5	0.31	<0.5
Cadmium		<0.7	<0.7	0.456	<0.7
Chromium		9.99	8.23	12.7	14.1
Cobalt		1.28	0.835	2.00	2.21
Copper		6.29	5.32	12.6	14.1
Cyanide		NS	NS	NS	NS
Lead		17.9	8.72	44.9	8.81
Manganese		108	95.5	199	196
Mercury		<0.05	<0.05	0.028	<0.05
Nickel		5.9	4.86	7.48	10.6
Selenium		<0.25	<0.25	<0.25	<0.25
Silver		<0.589	<0.589	<0.589	<0.589
Thallium		<6.62	<6.62	<6.62	<6.62
Vanadium		7.96	6.84	13.7	15
Zinc		21	17.3	49.7	34.8

NS - Not scheduled for analysis.

< Not detected at or above the value shown.

TABLE 4-2

BERENT SOILS (WESTERN TEAD-N, FINE-GRAINED) BACKGROUND ANALYTICAL RESULTS

Analyte (µg/g) Sample ID:	BK-92-04	BK-92-04	BK-93-05	BK-93-05	SB-BK-002	SB-BK-002	SB-BK-007	SB-BK-007	SB-BK-008	SB-BK-008	SB-BK-011	SB-BK-011	SB-BK-012	SB-BK-012
Date Collected:	7/15/92	7/15/92	7/21/93	7/21/93	7/26/92	7/26/92	11/4/93	11/4/93	11/4/93	11/4/93	10/6/93	10/6/93	10/6/93	10/6/93
Depth (ft):	0.0	3.0	0.5	3.5	0.0	2.0	0.0	3.0	0.0	3.0	0.0	3.0	0.0	3.0
Aluminum	NS	NS	8630	4380	8910	2590	3970	3030	9210	5140	4580	3140	5780	7430
Antimony	<34	<34	<0.3	<0.3	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14
Arsenic	<72 (1)	<240 (1)	5.2	<2.5	6.1	5.8	4.00	3.60	8.8	7.60	2.67	2.36	3.74	3.31
Barium	160	99.0	75.9	64.6	86	38.7	58.3	41.5	112	64.7	63.1	70.2	70.6	97.7
Beryllium	<0.078	<0.078	<0.427	<0.078	1.2	<0.50	<0.50	<0.50	0.544	0.393	0.296	<0.50	0.36	0.388
Cadmium	<0.424	<0.424	<1.2	<1.2	0.814	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70	<0.70
Chromium	13.2	9.3	10.1	9.33	11.9	6.85	5.1	4.15	11.8	13.5	5.39	4.24	7.14	9.0
Cobalt	NS	NS	4.16	4.40	4.07	2.15	2.61	1.94	4.78	3.12	2.67	2.16	3.33	3.64
Copper	11.9	5.8	12.2	6.37	17.8	6.51	7.19	4.24	16.2	8.2	7.25	3.72	11.8	7.39
Cyanide	<5.0	<5.0	NS	NS	<0.92	<0.92	NS	NS	NS	NS	NS	NS	NS	NS
Lead	16	7.7	17.1	6.46	32.5	5.74	8.97	<10.5	17.2	9.12	10.2	<10.5	13.9	6.63
Manganese	NS	NS	234	171	232	84.8	216	124	370	202	215	159	227	229
Mercury	<0.026	<0.026	<0.050	0.057	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel	<2.46	<2.46	7.72	9.1	9.26	5.14	6.41	5.47	11.2	8.5	8.33	24.4	15	26.5
Selenium	<510 (1)	<510 (1)	<0.449	<0.449	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.198	<0.25
Silver	0.069	0.042	<0.803	<0.803	0.634	<0.589	<0.589	<0.589	<0.589	<0.589	<0.589	<0.589	<0.589	<0.589
Thallium	<170 (1)	<170 (1)	<34.3	<34.3	<6.62	<6.62	10.2	7.58	14.8	10.9	4.72	7.09	10.2	13.9
Vanadium	NS	NS	13.3	10.5	15.9	9.40	9.16	7.86	16.3	12.4	7.83	7.53	9.62	16
Zinc	54.0	26.9	33	18.3	54.1	18	23.7	14.9	43.6	25.3	25.1	19	28.4	33.2

NS Not scheduled for analysis.
< Not detected at the value shown.
(1) Statistical outlier; not included in summary statistics due to elevated detection limit.

TABLE 4-3

HIKO PEAK SOILS
(WESTERN TEAD-N, COARSE-GRAINED)
BACKGROUND ANALYTICAL RESULTS

Analyte (µg/g)	Sample ID: / Date Collected: / Depth (ft):	BK-92-02 / 7/15/92 / 0.0	BK-92-02 / 7/15/92 / 2.0	SB-BK-001 / 7/26/92 / 0.0	SB-BK-001 / 7/26/92 / 3.0	SB-BK-004 / 7/27/92 / 0.0	SB-BK-004 / 7/27/92 / 3.0
Aluminum		NS	NS	9510	2280	17100	10900
Antimony		<34	<34	<7.14	<7.14	<7.14	<7.14
Arsenic		<120 (1)	<48 (1)	4.04	3.22	6.55	6.86
Barium		190	100	92.6	36.7	169	147
Beryllium		<0.078	<0.078	1.21	0.633	1.53	1.29
Cadmium		<0.424	<0.424	<0.7	<0.7	<0.7	<0.7
Chromium		16.5	13.5	10.4	<4.05	19.5	15.2
Cobalt		NS	NS	3.98	2.08	6.87	5.66
Copper		29	10.7	9.34	3.36	15	11.3
Cyanide		<5	<5	<0.92	<0.92	NS	<0.92
Lead		62	0.79	8.5	4.36	12	10.9
Manganese		NS	NS	273	85.1	477	376
Mercury		<0.026	<0.026	<0.05	<0.05	<0.05	<0.05
Nickel		<2.46	<2.46	9.73	4.35	17.9	14.2
Selenium		<510 (1)	<510 (1)	<0.25	<0.25	<0.25	<0.25
Silver		0.121	0.066	<0.589	<0.589	<0.589	<0.589
Thallium		<83 (1)	<170 (1)	<6.62	<6.62	<6.62	<6.62
Vanadium		NS	NS	15.1	8.48	27.7	23.8
Zinc		84	40	39.6	13.8	65.1	53.8

NS Not scheduled for analysis
< Not detected at or above the value shown
(1) Statistical outlier; not included in summary statistics due to elevated detection limit.

TABLE 4-4

MEDBURN SOILS
BACKGROUND ANALYTICAL RESULTS
EASTERN TEAD-N, FINE-GRAINED

Analyte (µg/g)	Sample ID:	BK-92-01	BK-92-01	SB-BK-003	SB-BK-003	SB-BK-005	SB-BK-005	SB-BK-013	SB-BK-013	SB-BK-014	SB-BK-014	SB-BK-015	SB-BK-015
	Date Collected:	7/15/92	7/15/92	7/26/92	7/26/92	7/27/92	7/27/92	10/23/93	10/23/93	10/23/93	10/23/93	10/23/93	10/23/93
	Depth (ft):	0.0	3.0	0.0	2.0	0.0	3.0	0.0	3.0	0.0	3.0	0.0	3.0
Aluminum		NS	NS	13200	12100	6550	4460	5370	1590	13000	8100	12400	2600
Antimony		<34	<34	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14	<7.14
Arsenic		<120 (1)	<240 (1)	24.0	19.0	19.0	16.0	7.80	3.97	11.7	8.00	8.52	5.80
Barium		270	190.0	188	157	92.2	64.9	78.3	41.2	173	130	113	37.0
Beryllium		<0.23	<0.078	1.35	1.26	0.638	0.838	<0.50	<0.50	0.809	0.48	0.883	0.429
Cadmium		<1.3	<0.424	0.847	<0.70	<0.70	<0.70	<0.70	<0.70	0.62	<0.70	<0.70	<0.70
Chromium		12.6	19.0	15.6	14.4	9.87	10.3	7.98	7.48	15.5	13.8	16.8	8.91
Cobalt		NS	NS	5.39	4.06	2.57	2.67	2.51	<1.42	4.31	3.04	3.98	1.27
Copper		12.7	13.0	23.1	15.9	10.4	4.83	9.4	3.94	22.2	10.7	12.7	4.58
Cyanide		<5.0	<5.0	<0.92	NS	<0.92	<0.92	NS	NS	NS	NS	NS	NS
Lead		17	22	55.5	32.7	30.5	10.7	11.9	<10.5	43.7	11.0	16.7	6.46
Manganese		NS	NS	458	370	195	140	201	68.2	481	264	370	108
Mercury		0.037	<0.026	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nickel		<2.46	<7.5	13.1	11.2	7.19	8.14	7.29	3.76	12.2	8.96	11.1	5.67
Selenium		NS	<5100 (1)	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Silver		0.212	0.079	0.660	<0.589	<0.589	<0.589	<0.589	<0.589	<0.589	<0.589	<0.589	<0.589
Thallium		<83.0 (1)	<170 (1)	9.60	<6.62	<6.62	<6.62	5.06	7.81	<6.62	<6.62	<6.62	4.75
Vanadium		NS	NS	20.5	19.4	13.1	23.1	7.88	5.75	19.5	16.2	18.0	7.92
Zinc		85.0	70.0	107	76.2	59.4	26.9	28.8	11.0	88.7	57.0	49.1	14.3

NS Not scheduled for analysis
< Not detected at the value shown
(1) Statistical outlier; not included in summary statistics due to elevated detection limit.

4.1.2.4. Prior to combining or separating sample populations based on statistical analyses, the specific metals showing a difference, the magnitude of the difference, and the effects of separating or combining the populations were evaluated. The following are examples of how these other non-statistical criteria were utilized in addition to the statistical analyses:

- If two sample populations were statistically the same for all metals except for a small number of dissimilar metals with relatively low toxicity (e.g., aluminum and cobalt), the individual concentration data might be combined because the sample populations are more similar than different.

- If the soil types were the same except for cadmium and lead, the populations would not be combined because these metals are suspected contaminants and have a relatively high toxicity.

- If the statistical difference between means was small (e.g., 20 percent), the difference was not given as much weight as if the difference was large (e.g., 100 percent) in deciding if the sample populations were the same or different.

- The impacts on the estimates of the upper threshold values (discussed below) were taken into account before the results of the statistical analyses were used to separate or combine sample populations. For instance, separating soil types into two different populations could result in an upper bound estimate for background that was artificially elevated because of the effect of the reduction in the degrees of freedom (number of samples) on the upper bound calculation.

4.1.2.5. Surface and Subsurface Soil Comparisons. Prior to investigating the differences between the four soil types, each soil type was examined for differences between the surface and subsurface concentrations. A difference was expected because of air deposition on the surface soil, especially for common anthropogenic airborne elements or compounds such as lead. If the differences between elevated metals concentrations of the investigated SWMUs and background concentrations were minor, separating the surface samples from the subsurface samples would be justified. However, the differences between background concentrations and metals concentrations at the investigated SWMUs were often orders of magnitude, and the outcome of the

contamination assessment is unchanged regardless of whether the surface soil and subsurface soil have minor differences in their respective background values.

4.1.2.6. For each soil type, the means for samples collected from 0 to 0.5 feet bgs were compared to the means for samples collected from 0.5 to 3 feet bgs using the Students t-test for unpaired means. Differences with a two-tailed probability of a false positive of 0.05 or less were considered statistically significant. For the eastern and western coarse-grained soils, metals concentrations were not statistically different between the surface and subsurface samples. These samples were combined for background calculations. In the eastern fine-grained soil, mean values of the detected metals were higher in surface samples than in samples from the subsurface, but the differences were not statistically significant and these samples were also combined for background calculations (Table 4-5). For the western fine-grained soil, the average concentration was greater in surface soil than in the subsurface for aluminum, arsenic, barium, chromium, cobalt, copper, lead, manganese, thallium, vanadium, and zinc, but not for nickel. Differences were statistically significant for copper, lead, manganese, and zinc. As discussed in Section 4.1.2.4., other factors were considered prior to making decisions based on statistical results. The surface and subsurface western fine-grained soils were combined for background purposes because they are similar (i.e., a difference was seen in only four of nineteen metals). Also, the magnitude of differences for copper, lead, and zinc have little practical significance, and separation based on manganese alone is not justified.

4.1.2.7. Soil Type Comparison Results. After combining the surface and subsurface sample population data, both fine-grained and coarse-grained soil types were compared statistically (fine to fine and coarse to coarse) to see if they could be combined. Results of the eastern and western coarse-grained soil comparison found that, with the exception of cobalt, there was no statistical difference (Table 4-6). Because the mean difference for cobalt was only 3.1 mg/kg and cobalt is not a chemical of potential concern (see Section 3.2.6.), the background data from the eastern and western coarse-grained soils were combined to represent coarse-grained soils Depot-wide.

4.1.2.8. By contrast, when the eastern and western fine-grained soils were compared, the concentrations of arsenic, barium, chromium, lead, thallium, and zinc were statistically different (Table 4-6). Although the magnitude of the differences is small, these constitute 50 percent of the analytes. Therefore, the fine-grained soils were treated as two separate soil types.

TABLE 4-5

SURFACE AND SUBSURFACE SOIL COMPARISON RESULTS

	Western Fine-Grained Soil		Eastern Fine-Grained Soil	
	Surface vs. Subsurface[(a)]		Surface vs. Subsurface[(a)]	
Analyte	Statistically[(b)] Significant Difference	Average[(c)] Difference mg/kg	Statistically[(b)] Significant Difference	Average[(c)] Difference mg/kg
Aluminum	No difference	--	No difference	--
Antimony	No difference	--	NC	--
Arsenic	No difference	--	No difference	--
Barium	No difference	--	No difference	--
Beryllium	NC	--	No difference	--
Cadmium	NC	--	NC	--
Chromium	No difference	--	No difference	--
Cobalt	No difference	--	No difference	--
Copper	Surface>Subsurface	6.02	No difference	--
Cyanide	NC	--	NC	--
Lead	Surface>Subsurface	10.0	No difference	--
Manganese	Surface>Subsurface	87.4	No difference	--
Mercury	NC	--	NC	--
Nickel	No difference	--	No difference	--
Selenium	NC	--	NC	--
Silver	NC	--	NC	--
Thallium	No difference	--	No difference	--
Vanadium	No difference	--	No difference	--
Zinc	Surface>Subsurface	15.2	No difference	--

NC Not calculated because analyte was below the detection level in at least one soil type.

(a) Surface soil from 0.0 to 0.5 feet bgs; subsurface soil from greater than 0.5 to 3.0 feet bgs.
(b) Students t-test for unpaired means statistically significant at a two-tailed probability of a false positive of 0.05 or less.
(c) The approximate magnitude of the difference observed between surface and subsurface soil.

TABLE 4-6

SOIL TYPE COMPARISON RESULTS

Analyte	Western Coarse-Grained vs. Eastern Coarse-Grained: Statistically[a] Significant Difference	Western Coarse-Grained vs. Eastern Coarse-Grained: Mean[b] Difference mg/kg	Western Fine-Grained vs. Eastern Fine-Grained: Statistically[a] Significant Difference	Western Fine-Grained vs. Eastern Fine-Grained: Mean[b] Difference mg/kg
Aluminum	No difference	--	No difference	--
Antimony	NC	--	NC	--
Arsenic	No difference	--	W<E	7.8
Barium	No difference	--	W<E	0.03
Beryllium	NC	--	NC	4
Cadmium	NC	--	NC	--
Chromium	No difference	--	W<E	4
Cobalt	W>E[c]	3.1	No difference	--
Copper	No difference	--	No difference	--
Cyanide	NC	--	NC	--
Lead	No difference	--	W<E	--
Manganese	No difference	--	No difference	--
Mercury	NC	--	NC	--
Nickel	No difference	--	No difference	--
Selenium	NC	--	NC	--
Silver	NC	--	NC	--
Thallium	NC	--	W>E	5.3
Vanadium	No difference	--	No difference	--
Zinc	No difference	--	W<E	26.3

NC Not calculated because analyte below the detect level in at least one soil type.

(a) Students t-test for unpaired means statistically sitnificant at a two-tailed probability of a false positive of 0.05 or less.

(b) The approximate magnitude of the difference observed between soil types.

(c) W = Western
E = Eastern

4.1.3. Data Evaluations

4.1.3.1. For the three resulting background soil types established (coarse-grained soils, eastern fine-grained soils, and western fine-grained soils), the percent detection, arithmetic mean, standard deviation, maximum concentration detected and other summary statistics for each analyte were calculated. The results are presented in Tables 4-7 through 4-9. In cases where analytical results were below the USAEC CRLs, a value equal to one-half the CRL was substituted. For many of the analytes (e.g., cyanide, mercury, selenium, thallium), the concentrations were below the CRLs; therefore, the reported means for these metals represent some limiting concentration value rather than representing an actual abundance in the soil.

4.1.3.2. To ensure statistical validity, the data sets generated for each analyte were first reviewed for any obviously anomalous values, and then checked for normal distributions. The lead concentration of 160 mg/kg (ppm) for the surface sample at location BK-92-03 was excluded from the data set for this calculation based on the observation that the sampled location is in, or near, a former firing range and ammunition test range. Because this one value appeared to be anomalous, and it skewed the statistical results, it was excluded from the population of lead concentrations. Several non-detect values were excluded because the limits of detection were much higher than the USAEC CRLs and detected values. Substituting a value of one-half the limit of detection or one-half of the CRL was inappropriate because this resulting value was greater than the maximum value detected and the difference between the CRL and the detection limit was large. The affected samples were collected by SEC Donahue in 1992 and include six results for arsenic, five results for selenium, and six for thallium. The data sets were checked for deviations from a normal distribution according to the coefficient of variation test (USEPA, 1989a). As shown in Tables 4-7 through 4-9, only two data sets (for lead in coarse-grained soils and beryllium for the western fine-grained soil) deviated slightly from a normal distribution. These deviations are not considered large enough to invalidate the use of parametric statistics.

4.1.3.3. To evaluate whether the analytical results from single soil samples may indicate contamination, several measures of an upper bounds of the distribution of soil constituents were calculated and are also included in Tables 4-7 through 4-9. The values for the 95% UCL and the 95%/95% upper tolerance limits (UTL; USEPA, 1989a) are listed, along with the arithmetic means plus two and three standard deviations. These limits generally describe a range of upper limit values above which concentrations may

TABLE 4-7

BACKGROUND STATISTICAL SUMMARY FOR METALS IN COARSE-GRAINED SOILS

Analyte	Total Number Samples	Number of Detections	Percent Detections	Mean	Standard Deviation	Coefficient of Variation (a)	Maximum Concentration Detected	Upper Second Standard Deviation	Upper Third Standard Deviation	Upper 95% Confidence Interval	Upper 95% Tolerance Value	Threshold Value
Aluminum	8	8	100.0	7615	5066	0.67	17100	17747	22813	11125	23765	**23765**
Antimony	10	0	0.0	--	--	--	--	--	--	--	--	**7.14(b)**
Arsenic	10	8	80.0	6.62	2.98	0.45	13.0	12.6	15.5	8.5	16.1	**16.1**
Barium	10	10	100.0	99.3	54.7	0.55	190	209	263	133.2	259	**259**
Beryllium	10	5	50.0	0.58	0.56	0.96	1.53	1.69	2.25	0.93	2.20	**2.20**
Cadmium	10	1	10.0	--	--	--	0.456	--	--	--	--	**0.456(c)**
Chromium	10	9	90.0	12.2	4.87	0.40	19.5	22.0	26.8	15.2	26.4	**26.4**
Cobalt	8	8	100.0	3.11	2.17	0.70	6.87	7.46	9.63	4.62	10.04	**10.04**
Copper	10	10	100.0	11.70	7.17	0.61	29.0	26.0	33.2	16.1	32.6	**32.6**
Cyanide	5	0	0.0	--	--	--	--	--	--	--	--	**0.92(b)**
Lead	10	10	100.0	17.9	19.69	1.10	62.0	57.3	77.0	30.1	75.2	**75.2**
Manganese	8	8	100.0	226	141.49	0.63	477	509	651	324	677	**677**
Mercury	10	0	0.0	--	--	--	--	--	--	--	--	**0.050(b)**
Nickel	10	8	80.0	7.75	5.43	0.70	17.9	18.6	24.0	11.11	23.5	**23.5**
Selenium	10	0	0.0	--	--	--	--	--	--	--	--	**0.25(b)**
Silver	10	2	20.0	--	--	--	0.121	--	--	--	--	**0.121(c)**
Thallium	10	0	0.0	--	--	--	--	--	--	--	--	**6.62(b)**
Vanadium	8	8	100.0	14.8	7.55	0.51	27.7	29.9	37.5	20.1	38.9	**38.9**
Zinc	10	10	100.0	41.9	22.1	0.53	84.0	86.2	108.3	55.6	106.3	**106.3**

All analytical results in µg/g.

"--" Statistical parameter not calculated.

(a) A coefficient of variation of <1.00 indicates a normal distribution.

(b) No detections in sample set; upper threshold set at Method CRL.

(c) Less than four detections in sample set; threshold set at the maximum detected value.

TABLE 4-8

BACKGROUND STATISTICAL SUMMARY FOR METALS IN EASTERN FINE-GRAINED SOILS

Analyte	Total Number Samples	Number of Detections	Percent Detections	Mean	Standard Deviation	Coefficient of Variation (a)	Maximum Concentration Detected	Upper Second Standard Deviation	Upper Third Standard Deviation	Upper 95% Confidence Interval	Upper 95% Tolerance Value	Threshold Value
Aluminum	10	10	100.0	7937	4472	0.56	13200	16881	21353	10709	20955	**20955**
Antimony	12	0	0.0	--	--	--	--	--	--	--	--	**7.14(b)**
Arsenic	10	10	100.0	12.38	6.71	0.54	24.0	25.8	32.5	16.5	31.9	**31.9**
Barium	12	12	100.0	127.9	70.2	0.55	270	268	339	168	320	**320**
Beryllium	12	8	66.7	0.61	0.43	0.70	1.35	1.47	1.90	0.85	1.78	**1.78**
Cadmium	12	2	16.7	0.43	0.18	0.42	0.85	0.79	0.97	0.53	0.85	**0.847(c)**
Chromium	12	12	100.0	12.7	3.75	0.30	19.0	20.2	23.9	14.8	22.9	**22.9**
Cobalt	10	9	90.0	3.05	1.42	0.47	5.39	5.90	7.32	3.93	7.20	**7.2**
Copper	12	12	100.0	11.95	6.23	0.52	23.1	24.4	30.6	15.5	29.0	**29.0**
Cyanide	5	0	0.0	--	--	--	--	--	--	--	--	**0.92(b)**
Lead	12	11	91.7	22.0	15.68	0.71	55.5	53.3	69.0	30.8	64.9	**64.9**
Manganese	10	10	100.0	266	146.80	0.55	481	559	706	357	693	**693**
Mercury	12	1	8.3	--	--	--	0.037	--	--	--	0.037	**0.037(b)**
Nickel	12	10	83.3	7.80	3.72	0.48	13.1	15.2	19.0	9.91	18.0	**18**
Selenium	11	0	0.0	--	--	--	--	--	--	--	--	**0.25(b)**
Silver	12	3	25.0	0.301	0.13	0.43	0.660	0.561	0.691	0.37	0.66	**0.660(c)**
Thallium	12	4	33.3	4.71	2.25	0.48	9.60	9.20	11.45	5.98	11.25	**11.25**
Vanadium	10	10	100.0	15.1	6.11	0.40	23.1	27.4	33.5	18.9	32.9	**32.9**
Zinc	12	12	100.0	56.1	30.9	0.55	107.0	118.0	148.9	73.6	140.8	**140.8**

"--" = Statistical parameter not calculated.
(a) A coefficient of variation of <1.00 indicates a normal distribution.
(b) No detections in sample set; upper threshold set at Method CRL.
(c) Less than four detections in sample set; threshold set at the maximum detected value.

TABLE 4-9

BACKGROUND STATISTICAL SUMMARY FOR METALS IN WESTERN FINE-GRAINED SOILS

Analyte	Total Number Samples	Number of Detections	Percent Detections	Mean	Standard Deviation	Coefficient of Variation (a)	Maximum Concentration Detected	Upper Second Standard Deviation	Upper Third Standard Deviation	Upper 95% Confidence Interval	Upper 95% Tolerance Value	Threshold Value
Aluminum	12	12	100.0	5566	2405	0.43	9210	10377	12782	6927	12147	**12147**
Antimony	14	0	0.0	--	--	--	--	--	--	--	--	**7.14(b)**
Arsenic	12	11	91.7	4.53	2.22	0.49	8.8	9.0	11.2	5.8	10.6	**10.6**
Barium	14	14	100.0	78.7	31.3	0.40	160	141	173	95.1	161	**161**
Beryllium	14	6	42.9	0.28	0.29	1.03	1.20	0.85	1.14	0.43	1.03	**1.03**
Cadmium	14	1	7.1	--	--	--	0.81	--	--	--	--	**0.81(c)**
Chromium	14	14	100.0	8.6	3.24	0.37	13.5	15.1	18.4	10.3	17.1	**17.1**
Cobalt	12	12	100.0	3.25	0.96	0.30	4.78	5.18	6.14	3.80	5.89	**5.89**
Copper	14	14	100.0	9.04	4.29	0.47	17.8	17.6	21.9	11.3	20.3	**20.3**
Cyanide	4	0	0.0	--	--	--	--	--	--	--	--	**0.92(b)**
Lead	14	12	85.7	11.6	7.44	0.64	32.5	26.5	33.9	15.5	31.0	**31**
Manganese	12	12	100.0	205	70.30	0.34	370	346	416	245	398	**398**
Mercury	14	1	7.1	--	--	--	0.057	--	--	--	--	**0.057(c)**
Nickel	14	12	85.7	9.96	7.49	0.75	26.5	24.9	32.4	13.88	29.5	**29.5**
Selenium	12	1	8.3	--	--	--	0.20	--	--	--	--	**0.20**
Silver	14	3	21.4	--	--	--	0.634	--	--	--	--	**0.634(c)**
Thallium	12	8	66.7	10.03	5.00	0.50	17.20	20.03	25.02	12.86	23.7	**23.7**
Vanadium	12	12	100.0	11.3	3.35	0.30	16.3	18.0	21.4	13.2	20.5	**20.5**
Zinc	14	14	100.0	29.8	12.7	0.43	54.1	55.2	67.8	36.5	63.0	**63**

"--" = Statistical parameter not calculated.

(a) A coefficient of variation of <1.00 indicates a normal distribution.

(b) No detections in sample set; upper threshold set at Method CRL.

(c) Less than four detections in sample set; upper threshold set at the maximum value detected.

be considered elevated with respect to the site-wide "background level." While such elevated values may indicate an anthropogenic contribution, they also may be due to location-specific processes (as may be present in local depositional environments) or may be outliers. Such occurrences are evaluated in the context of specific sources or risk and remediation data needs.

4.1.4. Determination of Upper Thresholds

4.1.4.1. Upper thresholds are the concentrations of metals and anions that are believed to represent the upper range of naturally-occurring values. Analytical results above the upper thresholds are considered to indicate a release of contaminants to the environment.

4.1.4.2. Three criteria were used to determine the upper threshold for background concentrations. First, if the sample population for each analyte contained four or more data points above the USAEC CRLs, it was considered to be statistically valid. In this case, the upper threshold was set at the 95 percent tolerance value based on USEPA guidance (USEPA, 1989a). In the case where the sample analyte population contained less than four but greater than zero detections, the upper threshold was set at the maximum concentration detected. Finally, in the case where there were zero detections in the sample analyte population, the upper threshold was set at the CRL, and any detection of that analyte in environmental samples would be considered above background.

4.2 UPGRADIENT (BACKGROUND) GROUNDWATER CONDITIONS AT SWMU 45

4.2.0.1. Because Phase I RFI data confirmed the presence of VOCs, SVOCs, pesticides, explosives and metals in the surface water and sediment at the Stormwater Discharge Area (SWMU 45), the contamination assessment was expanded to evaluate potential impacts to the groundwater beneath this area. Although the stormwater discharge pond is small (i.e., less than 10 to 20 ft across), the area has been used for decades and standing water has been observed there on a continuous basis. For this reason, there is a potential for chemicals detected in the sediment and surface water to have migrated to the underlying groundwater. To determine if the underlying groundwater has been impacted, the Phase II RFI included installation of a groundwater monitoring system at this SWMU.

4.2.1. Groundwater Sampling Program

4.2.1.1. The monitoring system installed at SWMU 45 consisted of one up-gradient and two down-gradient monitoring wells (N-142-93, N-143-93, and T-7, respectively). The locations of these monitoring wells are indicated in the Contamination Assessment for SWMU 45 (Section 14.3). Both N-142-93 and N-143-93 were installed in conjunction with the Phase II RFI field program and monitoring well T-7 is an existing well located about 700 feet downgradient of the stormwater discharge pond at SWMU 45.

4.2.1.2. To determine the upgradient (background) groundwater quality at SWMU 45, two rounds of groundwater samples were collected from the upgradient well (N-142-93). The samples were analyzed for a broad spectrum of potential contaminants including VOCs, SVOCs, pesticides/PCBs, explosives, and metals. These analytical results are believed to be representative of background groundwater conditions at SWMU 45, and are discussed below.

4.2.2. Sampling Results and Background Conditions

4.2.2.1. No organic compounds (VOCs, SVOCs, pesticides/PCBs, or explosives) were detected in either the upgradient or the downgradient groundwater samples at SWMU 45 as shown in the analytical results tables included in Appendices O and P. By contrast, naturally occurring concentrations of anions, cations, and metals were detected. The results of both rounds of groundwater sampling in the upgradient monitoring well (N-142-93) and nearby TEAD water supply well WW1, located approximately 1,500 feet south of SWMU 42, are included in Table 4-10. Although the location of water supply well WW1 is not directly upgradient of SWMU 42, it is believed to be a reliable measure of up-gradient groundwater quality in the general area.

4.2.2.2. As can be seen from Table 4-10, the principal components detected in upgradient groundwater were calcium, magnesium, potassium, sodium, chloride, sulfate, and bicarbonate ions. This type of groundwater is consistent with that identified during the Groundwater Quality Assessment for the Tooele Army Depot, North Area (GWQA; JMM, 1988). As indicated in Section 2.5.4. of this report, the GWQA report identified groundwater in the northern and central portions of TEAD-N as dominated by concentrations of sodium and chloride with, to a lesser extent, bicarbonate, calcium, and sulfate. This groundwater is thought to have originated as recharge from the Oquirrh Mountains with a minor contribution of more saline groundwater from the underflow

TABLE 4-10

UPGRADIENT (BACKGROUND) GROUNDWATER SAMPLING RESULTS AT SWMU 45

Sample ID **Lab ID** **Date Sampled** **Depth (ft)**	**N-142-93** **NWTR2*23** **11/22/93** **377 ft**	**N-142-93** **NWTR2*70** **02/01/94** **377 ft**	**WW-1** **UBKET018** **6/11/90** **500 ft**
Metals (ug/l)			
Aluminum	< 141	< 141	< 112
Antimony	< 38.0	< 38.0	< 60.0
Arsenic	< 2.54	< 2.54	< 2.35
Barium	28.4	29.2	45.5
Beryllium	< 5.00	< 5.00	< 1.12
Cadmium	< 4.01	< 4.01	< 6.78
Calcium	185,000	182,000	280,000
Chromium	4.82	60.3	< 16.8
Cobalt	< 25.0	< 25.0	< 25.0
Copper	< 8.09	< 8.09	< 18.8
Iron	< 38.8	339	< 77.5
Lead	< 1.26	< 1.26	< 43.4
Magnesium	80,700	84,400	94,200
Manganese	10.9	11.6	< 9.67
Mercury	< 0.243	< 0.243	< 0.10
Nickel	< 34.3	< 34.3	< 32.1
Potassium	6,640	7,080	6,840
Selenium	4.47	4.69	6.26
Silver	< 4.60	< 4.60	< 10
Sodium	138,000	143,000	180,000
Thallium	< 6.99	< 6.99	< 125
Vanadium	< 11.0	< 11.0	< 27.6
Zinc	83.0	84.9	92.4
Chloride	490,000	490,000	400,000
Sulfate	1,000,000	300,000	360,000
Alkalinity (bicarbonate)	250,000	220,000	NA
TDS	NA	1,400,000	NA

< Not detected at indicated concentration.
NA Compound or analytical group was not analyzed.

Samples were collected as unfiltered samples.

from Rush Valley. Additional discussions of groundwater quality beneath the Stormwater Discharge Area are included in the contamination assessment section for SWMU 45 in this document.

4.3 DATA REPORTING LIMIT EVALUATION

4.3.1. Background

4.3.1.1. The Corrective Action Permit for TEAD-N specifies USEPA SW-846 (USEPA, 1989) PQLs for reporting analytical data. Because the USAEC CRLs are not always consistent with these PQLs, this section discusses the efforts to meet the PQL reporting requirement.

4.3.2. Data Reporting Methodology

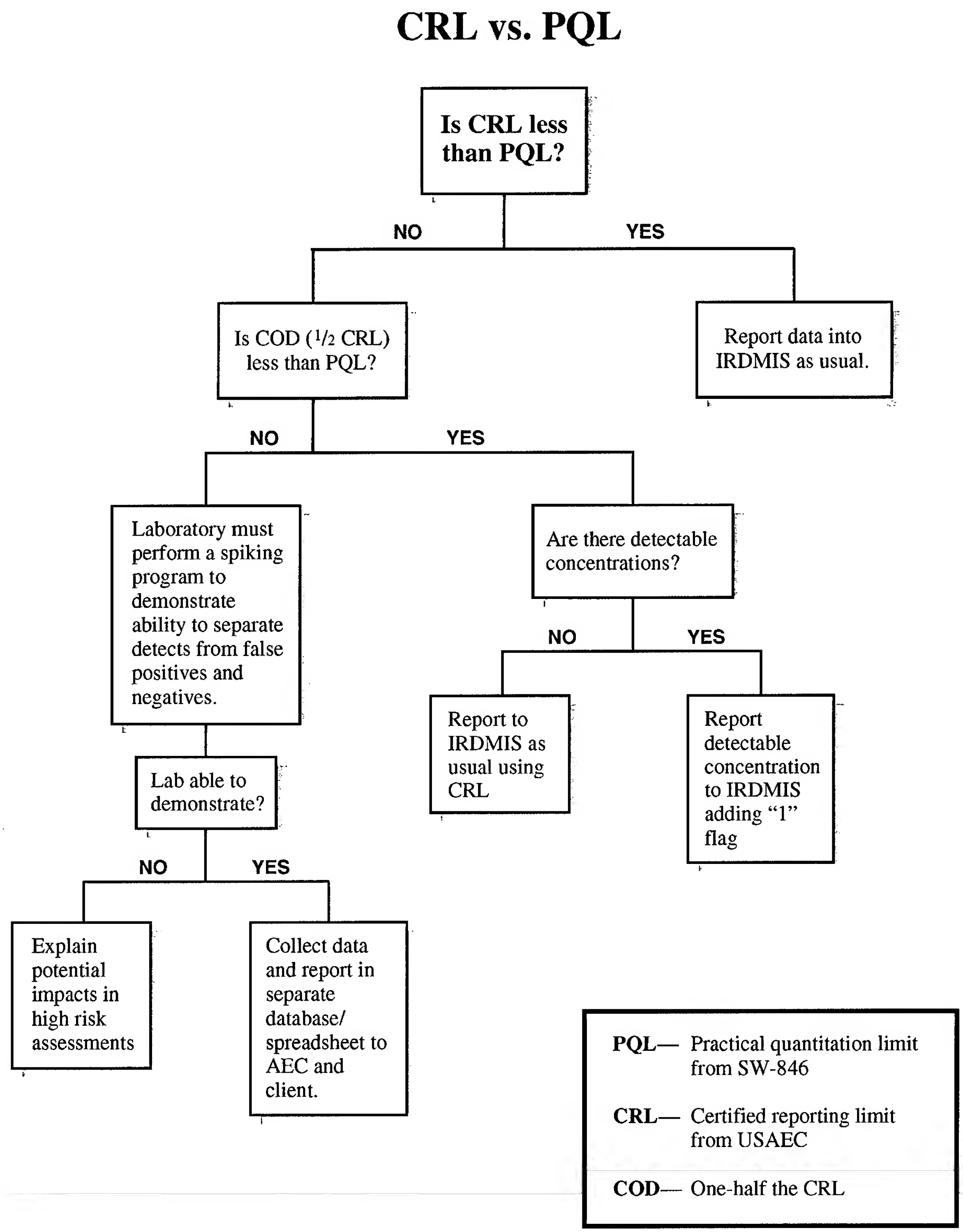
4.3.2.1. To best comply with the reporting requirements in the TEAD-N Correction Action Permit, a detailed procedure for data reporting was developed. This procedure is shown as a flow chart in Figure 4-1. The laboratory summary report prepared by Environmental Science and Engineering (ESE) that addresses this reporting procedure, the results, and how they will be included in the analytical data base (Installation Restoration Data Management System; IRDMIS) is included as Attachment E-3 in Appendix E. This methodology is summarized as follows:

1. Use normal reporting methods when the USAEC CRL is below the corresponding SW-846 PQL

2. When one-half of the CRL (criteria of detection, COD) is below the SW-846 PQL, report with the flagging code "1"

3. When the COD is above the SW-846 PQL the laboratory must demonstrate, by spiking, the ability to accurately report to the lower levels. To demonstrate this ability, four standard matrix spikes were analyzed with two blanks and two spiked at the SW-846 PQL.

4. Because values greater than the PQL and less than the COD cannot be submitted to the IRDMIS, separate reports have been generated and submitted for any analyses that fall into this group.



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TEAD-N RFI—GROUP A SWMUs
DATA REPORTING PROCEDURES
FIGURE 4-1

4.3.3. Summary of Results

4.3.3.1. Based on the detection limit review and comparisons included in the ESE report (see Appendix E), the SW-846 PQLs have been met or exceeded for 418 of 422 analytes included in the TEAD investigation programs. Results that are less than the COD, greater than the PQL, and considered valid based on the spiking program are presented in supplemental tables in Appendices O and P. Also, values in the data tables downloaded from IRDMIS in these two appendices have been annotated by hand with the flagging code "4" where there are supplemental data to refer to. Based on the results of the reporting limit comparison and spiking program, it appears that meeting SW-846 PQLs for the following two metals and two semivolatiles in soil is not possible.

USAEC Method	IRDMIS Code	Compound/Analyte
LM18	33DCBD	3,3-Dichlorobenzidine
	CL6CP	Hexachlorocyclopentadiene
JS16	TL	Thallium
	PB	Lead

To address concerns that may arise as a result of the elevated reporting levels for these analytes, a discussion of the impacts that they have on risk assessment calculations is included here.

4.3.3.2. Of the four chemicals that could not be reliably quantified to SW-846 PQLs, only lead and thallium were detected. Lead and thallium were analyzed with USAEC contract reporting limits 3 and 17 times higher, respectively, than their practical quantitation limits specified under SW-846. Thus, it is possible that these metals were not detected by the USAEC Methods. However, this does not alter the results of the risk assessment. The CRL for lead of 10.5 mg/kg is below the background levels of lead. Therefore, all lead above background levels (i.e., lead that is due to environmental contamination) could be detected. The thallium CRL of 6.62 mg/kg, however, is above the background level found in coarse-grained soil at TEAD-N (see Section 4.1). The presence of thallium could be detected at one half the CRL, or 3.31 mg/kg, although the ability to quantify the concentration is reduced at this level. By using the exposure assumptions in Appendix K, the hazard quotient for a child exposed to soil with this concentration of thallium in a residential scenario is 0.3, which indicates that adverse

effects are not expected. Because concentrations of thallium at the CRL are not associated with adverse effects in children (who are exposed to more soil than any other receptor), the CRL for thallium is sufficiently low for the purposes of this risk assessment.

4.3.3.3. The CRLs for 3,3-dichlorobenzidene and hexachlorocyclopentadiene were also low enough such that the potential presence of these compounds does not alter the results of the risk assessment (since they were never detected). The COD for 3,3-dichlorobenzidene (i.e., one half the CRL) was 3.15 μg/kg. By using the exposure assumptions in Appendix K, the cancer risk for a person exposed to soil with this concentration of 3,3-dichlorobenzidene would be 1×10^{-6}. The COD for hexachlorocyclopentadiene was 3.2 μg/kg. By using the exposure assumptions in Appendix K, the hazard quotient for a child exposed to this concentration of hexachlorocyclopentadiene in soil would be 0.009. Consequently the CRLs for these compounds were low enough such that they would have been detected if present at concentrations posing potentially unacceptable risks.

5.0 MAIN DEMOLITION AREA (SWMU 1)

5.1 SITE BACKGROUND

5.1.0.1. Site Description. The Main Demolition Area, part of the larger Open Burning/Open Detonation (OB/OD) Area, is located in the southwestern corner of the TEAD-N facility, southwest of the Ordnance Area. For the purposes of this investigation, the OB/OD Area was initially divided into five separate subunits based on previous site activities as shown on Figure 5-1. These subareas include:

- The Main Demolition Area—SWMU 1
- The Cluster Bomb Detonation Area—SWMU 1a
- The Burn Pad—SWMU 1b
- The Trash Burn Pits—SWMU 1c
- The Propellant Burn Pans—SWMU 1d

Each of these subareas will be treated individually in Sections 5.0 through 8.0.

5.1.0.2. The Main Demolition Area comprises the largest part of the Open Burning/Open Detonation Area. The OB/OD subareas are located in valleys between several small hills which isolate these subareas from the rest of the Depot. The hills are well-developed gravel bars deposited by Lake Bonneville.

5.1.0.3. During the Phase I RFI, the Cluster Bomb Detonation Area (SWMU 1a) was found to have only sporadic low levels of contamination. Since this SWMU is physically contained within the larger Main Demolition Area (SWMU 1), it was addressed within the context of SWMU 1 and was not investigated separately during Phase II activities.

5.1.0.4. Operational Activities. The Main Demolition Area has been used since the 1940s for various demilitarization activities, including munitions detonation, propellant flashing, and the disposal of various materials from the TEAD-N facility by burning and/or burial. SWMU 1 is currently used for emergency demilitarization of bombs, rocket motors, and other explosive munitions. Past activities have included open burning and open detonation of numerous types of munitions and other items in open trenches. As trenches became full of debris and residue, they were backfilled and new trenches were excavated. Burial is no longer used as a means of waste disposal. According to

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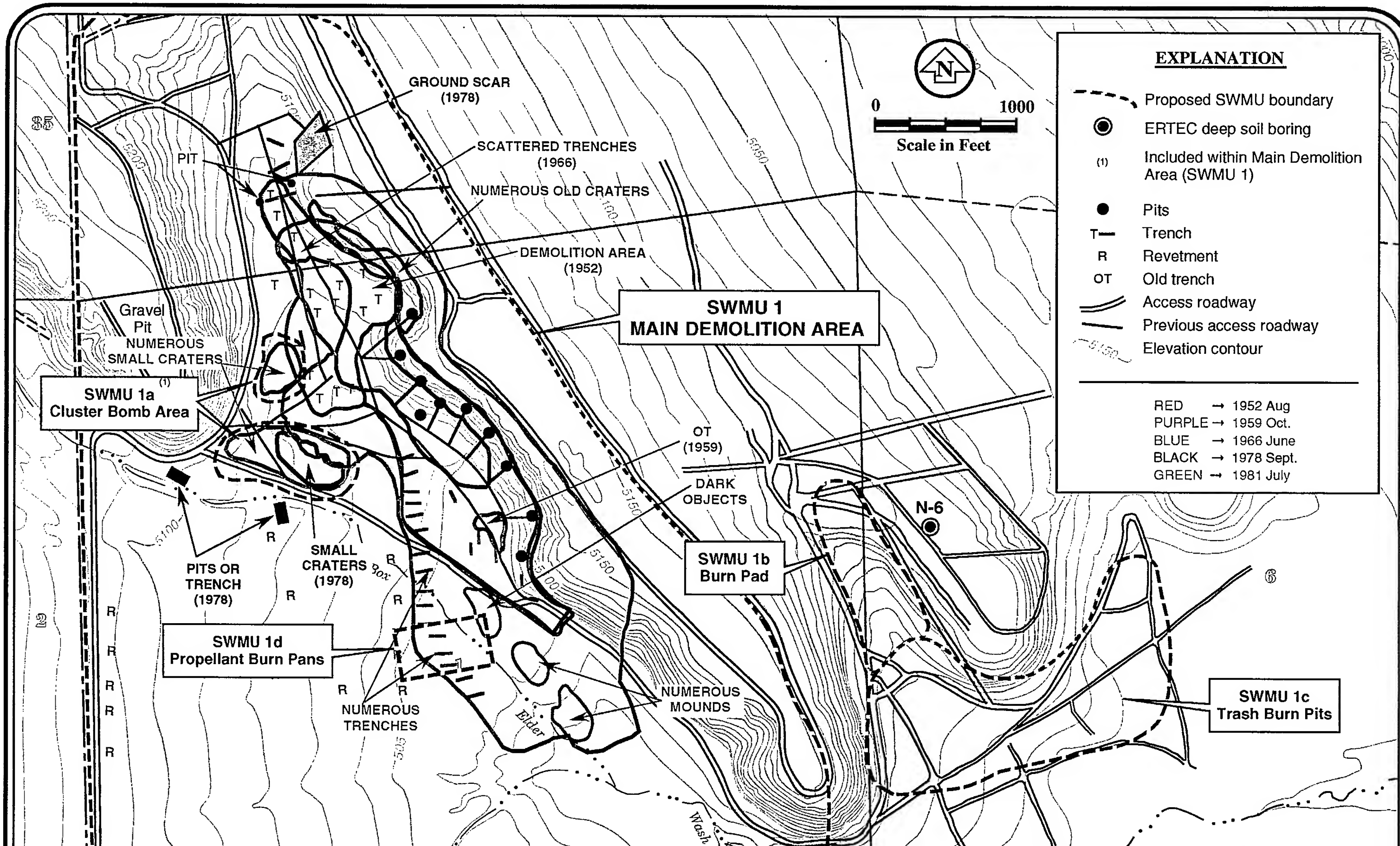

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Source: Base map modified from USGS Grantsville and SouthMountain 7.5 minute quadrangles.
Features from EPIC aerial photographs, 1952–1981

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
MAIN DEMOLITION AREA—SWMU 1, 1a
LOCATION MAP AND SITE FEATURES
FIGURE 5-1

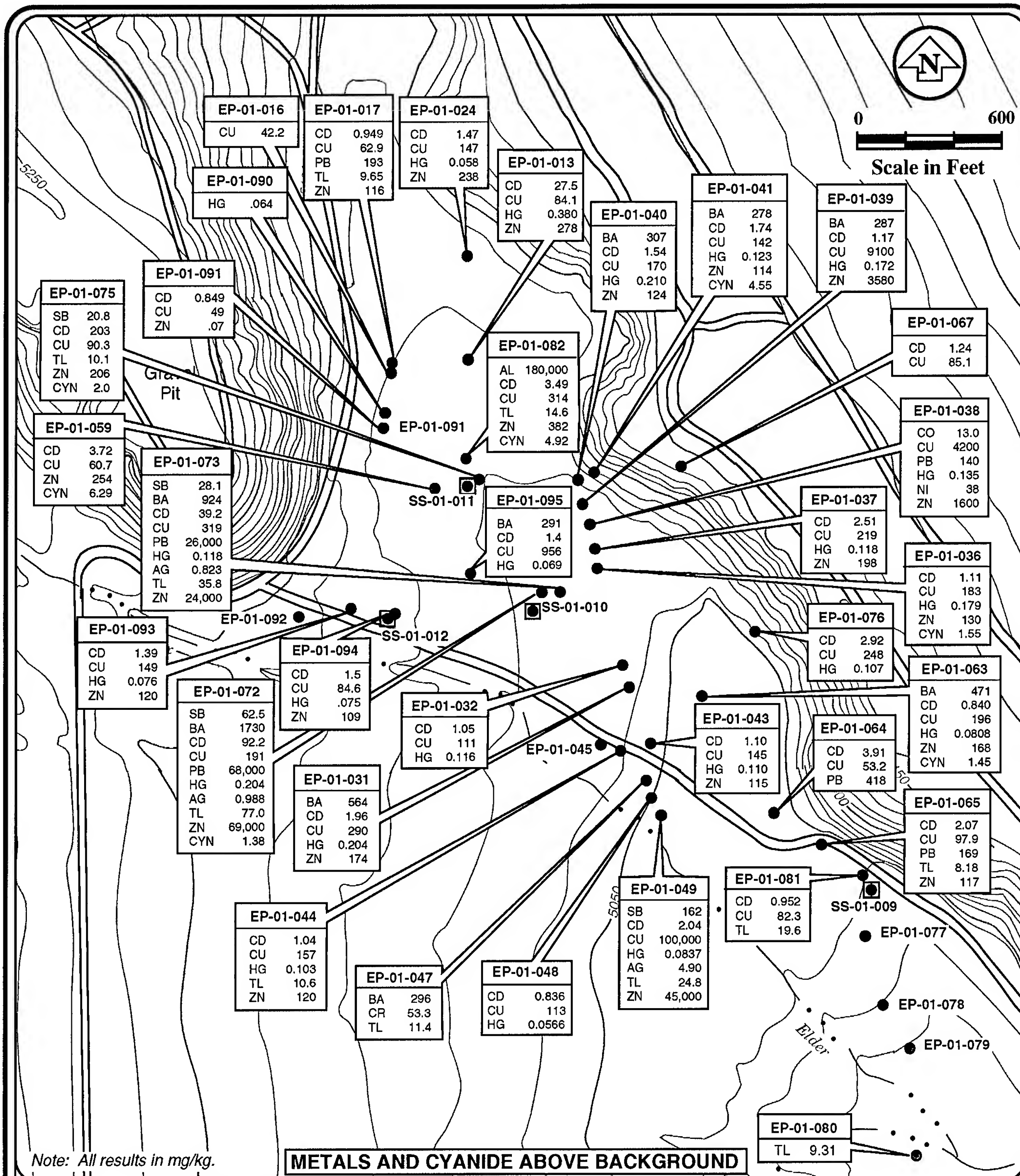
available information, chemical warfare agents have not been stored, processed, or handled at any of the TEAD-N OB/OD subareas.

5.1.0.5. At the Main Demolition Area, several types of munitions, from small arms projectiles to 12,000-pound bombs, have been detonated. This area has been active since about 1942, and the amount of munitions treated varies widely from year to year. According to the TEAD-N ammunition directorate, the area was used only occasionally during 1985 to 1988. By contrast, during 1990 approximately 9,000 tons of munitions were treated (Rutishauser, 1991). To detonate munitions in this area, a pit is dug and the munitions are placed in the bottom. The pit is then covered with fill, and the munitions are detonated. After detonation, the area is searched manually for unexploded ordnance (UXO). If UXO are encountered, they are redetonated. The Cluster Bomb Detonation Area (SWMU 1a) reportedly was used for about five or six years to demilitarize cluster bomb munitions. Operations ceased at SWMU 1a in 1977 (AEHA, 1983).

5.1.0.6. Geology and Hydrology. The OB/OD Area (including the Main Demolition Area) is located near the eastern base of the Stansbury Mountains in an erosional dissection of a delta formed by Pleistocene Lake Bonneville (AEHA, 1984). Soils underlying the Main Demolition Area have been mapped by the U.S. Soil Conservation Service as Hiko Peak Series and are composed of gravelly loams developed in alluvium from mixed rock types. Depth to bedrock in this area is generally greater than 700 feet. The depth to the regional groundwater table is over 700 feet based on a soil boring (designated N-6) located about one-half mile east of SWMU 1, which was drilled to 709 feet bgs without encountering the water table (ERTEC, 1982). The boring encountered coarse granular soils as follows:

- Zero to 100 feet bgs: Sand and gravel
- 100 to 200 feet bgs: Silty sands, gravels, and sandy clayey silt
- 200 to 500 feet bgs: Gravelly sands and sandy gravels
- 500 to 670 feet bgs: Gravels
- 670 to 709 feet bgs: Clayey sandy gravels.

5.1.0.7. The OB/OD Area is reportedly located at the margin of a seasonal groundwater recharge area. During years of high precipitation, melting snow in the spring extends from the regional recharge areas along the Stansbury Mountains into the OB/OD Area (AEHA, 1983). As is characteristic of this semi-arid climate, surface water flow is limited to infrequent heavy precipitation events. Drainage is to the south and southwest



Source: Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.

EXPLANATION

- ● Test pit location
- ▣ Surface soil sample location *(Sampled for total chromium and hexavalent chromium only.)*
- Access roadway
- —5050— Elevation contour line
- • • • Intermittent stream bed

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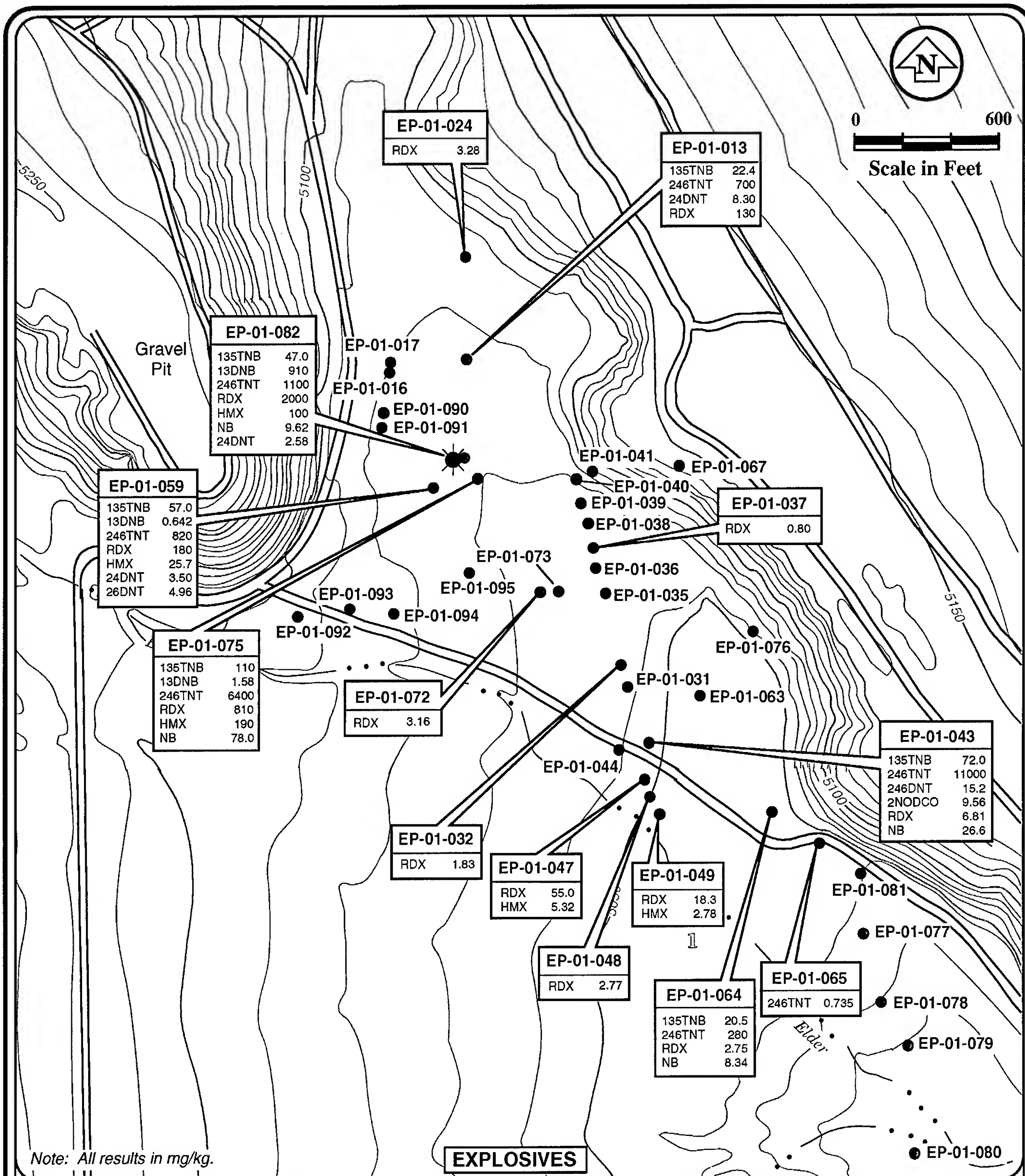
TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
MAIN DEMOLITION AREA—SWMU 1, 1a
ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES
FIGURE 5-2

PROJECT NO. 2942.0190



Source: Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.

EXPLANATION

- ● Test pit location
- Explosive reactivity sample location
- Access roadway
- 5050 Elevation contour line
- • • • Intermittent stream bed

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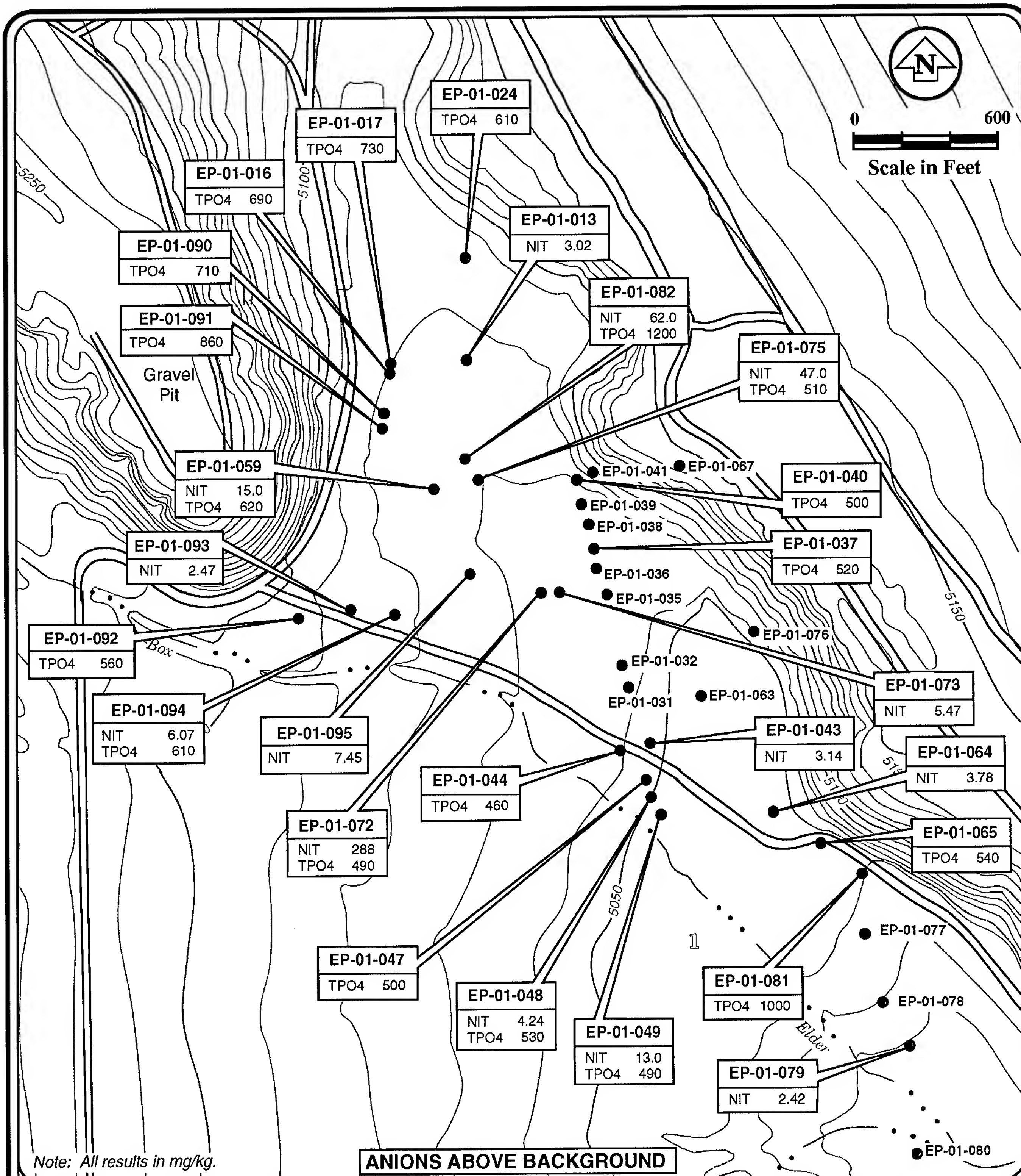
TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
MAIN DEMOLITION AREA—SWMU 1, 1a
ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES
FIGURE 5-3

PROJECT NO. 2942.0190



Source: *Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.*

EXPLANATION

- ● Test pit location
- Access roadway
- 5050 Elevation contour line
- • • • Intermittent stream bed

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA

MAIN DEMOLITION AREA—SWMU 1, 1a
ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES

FIGURE 5-4

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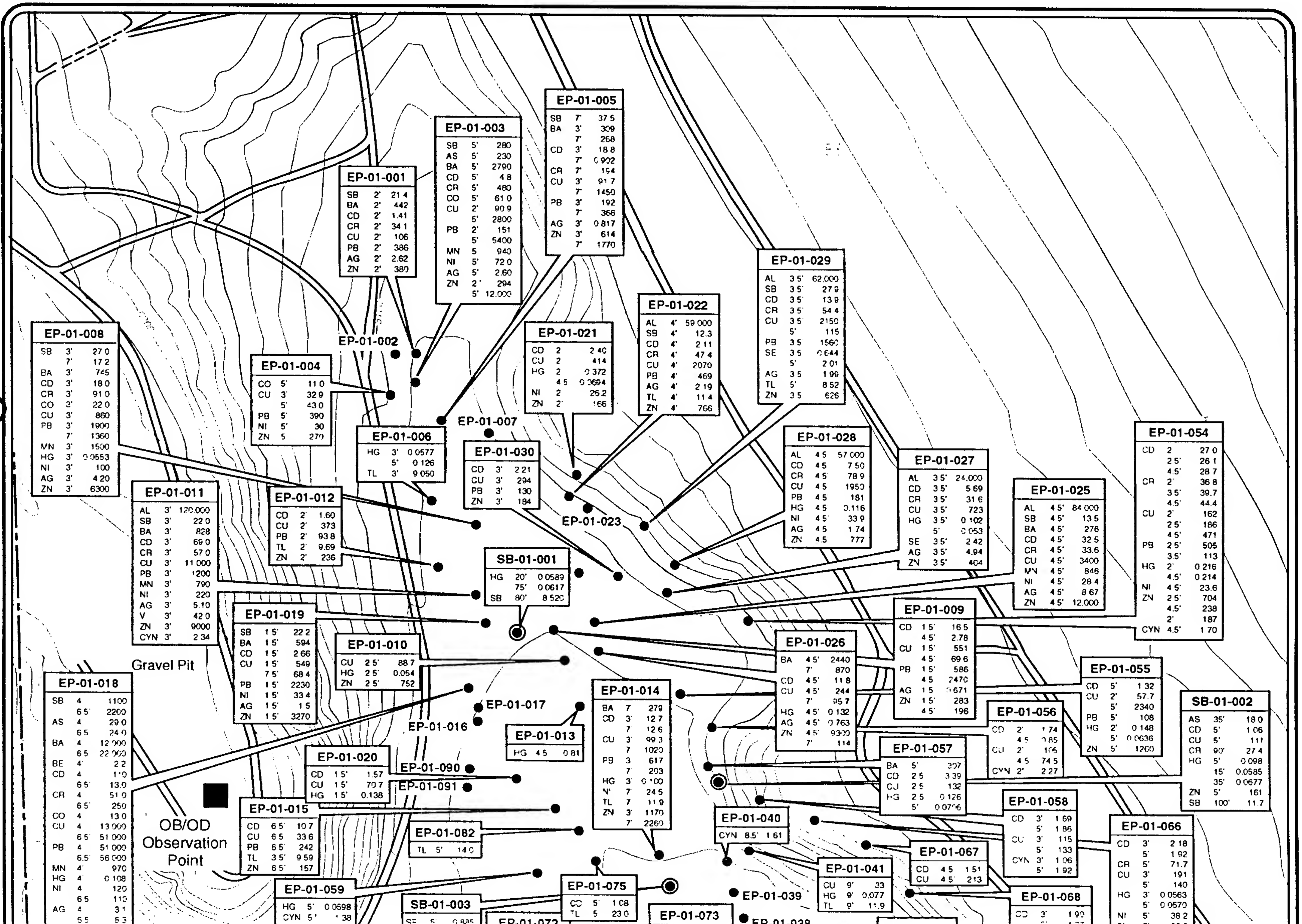

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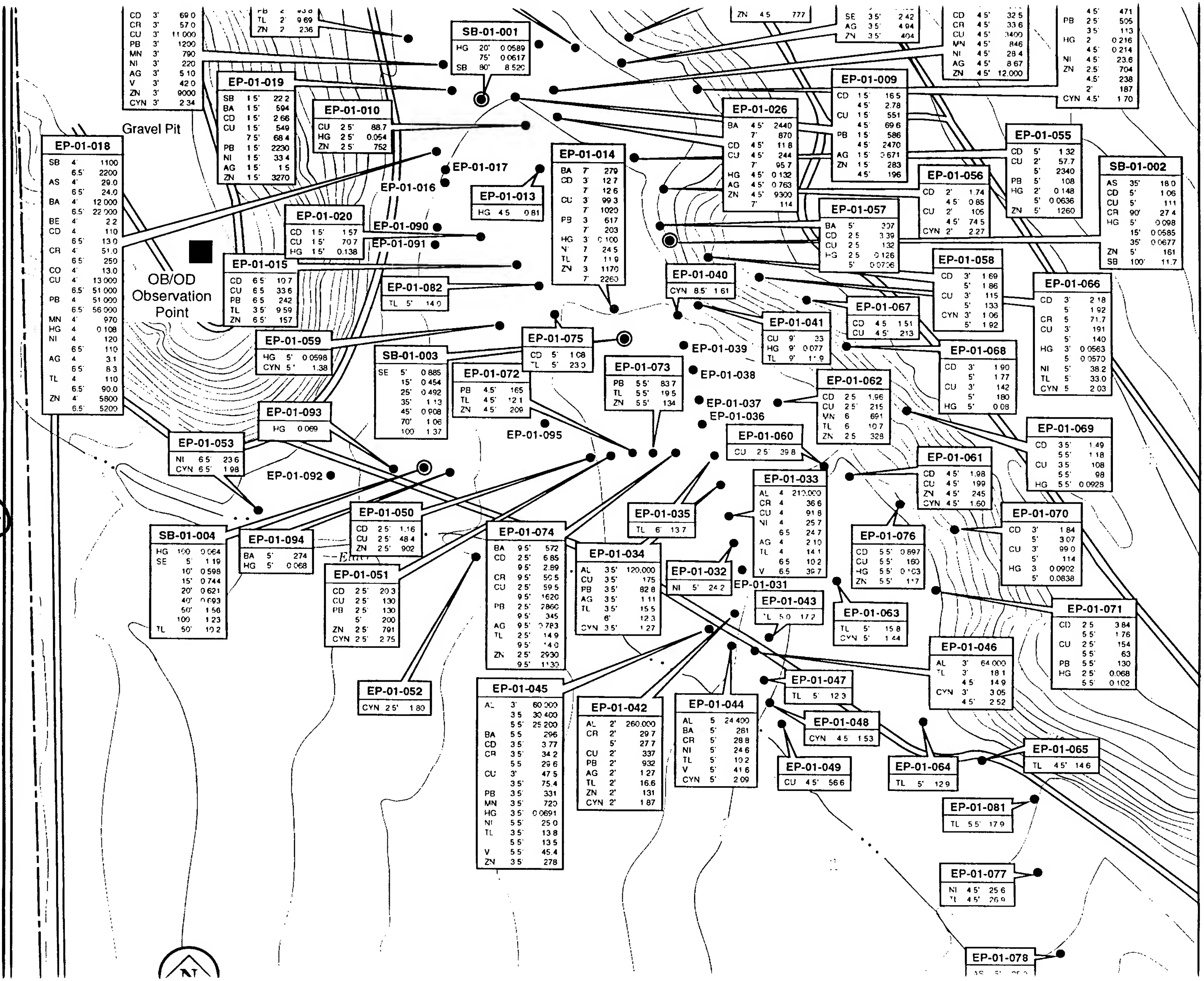
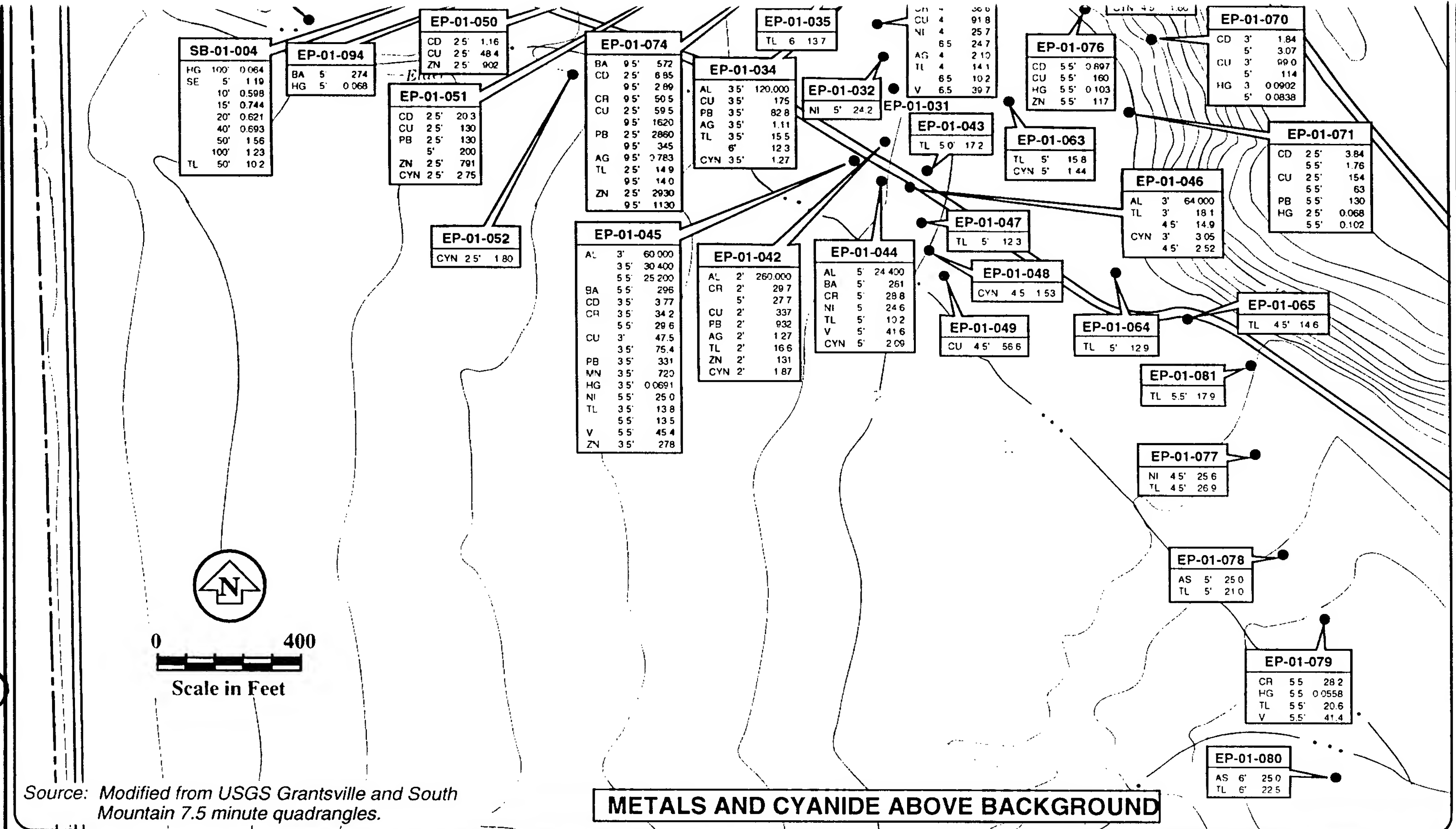


Gravel Pit
OB/OD Observation Point
CD 3' 69.0
CR 3' 57.0
CU 3' 11,000
PB 3' 1200
MN 3' 790
NI 3' 220
AG 3' 5.10
V 3' 42.0
ZN 3' 9000
CYN 3' 2.34
TL 2' 9.69
ZN 2 236
EP-01-018
SB 4' 1100
6.5' 2200
AS 4' 29.0
6.5' 24.0
BA 4' 12,000
6.5' 22,000
BE 4' 2.2
CD 4 110
6.5' 13.0
CR 4' 51.0
6.5' 250
CO 4' 13.0
CU 4' 13,000
6.5' 51,000
PB 4 51,000
6.5' 56,000
MN 4' 970
HG 4 0.108
NI 4 120
6.5' 110
AG 4 3.1
6.5' 8.3
TL 4 110
6.5' 90.0
ZN 4' 5800
6.5' 5200
EP-01-019
SB 1.5' 22.2
BA 1.5' 594
CD 1.5' 2.66
CU 1.5' 549
7.5' 68.4
PB 1.5' 2230
NI 1.5' 33.4
AG 1.5' 1.5
ZN 1.5' 3270
EP-01-010
CU 2.5' 88.7
HG 2.5' 0.054
ZN 2.5' 752
SB-01-001
HG 20' 0.0589
75' 0.0617
SB 80' 8.520
EP-01-017
EP-01-016
EP-01-013
HG 4.5 0.81
EP-01-020
CD 1.5' 1.57
CU 1.5' 70.7
HG 1.5' 0.138
EP-01-090
EP-01-091
EP-01-015
CD 6.5' 10.7
CU 6.5 33.6
PB 6.5 242
TL 3.5' 9.59
ZN 6.5' 157
EP-01-082
TL 5' 14.0
EP-01-059
HG 5' 0.0598
CYN 5' 1.38
EP-01-093
HG 0.069
EP-01-053
NI 6.5' 23.6
CYN 6.5' 1.98
EP-01-092
SB-01-004
HG 100 0.064
SE 5' 1.19
10' 0.598
15' 0.744
20' 0.621
40' 0.693
50' 1.56
100 1.23
TL 50' 10.2
EP-01-094
BA 5' 274
HG 5' 0.068
EP-01-014
BA 7' 279
CD 3' 12.7
7' 12.6
CU 3' 99.3
7' 1020
PB 3 617
7' 203
HG 3' 0.100
NI 7 24.5
TL 7 11.9
ZN 3 1170
7' 2260
SB-01-003
SE 5' 0.885
15' 0.454
25' 0.492
35' 1.13
45' 0.908
70' 1.06
100 1.37
EP-01-075
CD 5' 1.08
TL 5' 23.0
EP-01-072
PB 4.5' 16.5
TL 4.5' 12.1
ZN 4.5' 209
EP-01-095
EP-01-050
CD 2.5' 1.16
CU 2.5' 48.4
ZN 2.5' 902
EP-01-051
CD 2.5' 20.3
CU 2.5' 13.0
PB 2.5' 13.0
5' 20.0
ZN 2.5' 79.1
CYN 2.5' 2.75
EP-01-052
CYN 2.5' 1.80
EP-01-074
BA 9.5' 572
CD 2.5' 6.85
9.5' 2.89
CR 9.5' 50.5
CU 2.5' 59.5
9.5' 1620
PB 2.5' 2860
9.5' 345
AG 9.5' 0.783
TL 2.5' 14.9
9.5' 14.0
ZN 2.5' 2930
9.5' 1130
EP-01-045
AL 3' 60,000
3.5 30,400
5.5' 25,200
BA 5.5 296
CD 3.5' 3.77
CR 3.5' 34.2
5.5 29.6
CU 3' 47.5
3.5' 75.4
PB 3.5' 331
MN 3.5' 720
HG 3.5' 0.0691
NI 5.5' 25.0
TL 3.5' 13.8
5.5' 13.5
V 5.5' 45.4
ZN 3.5' 278
EP-01-034
AL 3.5' 120,000
CU 3.5' 175
PB 3.5' 82.8
AG 3.5' 1.11
TL 3.5' 15.5
6' 12.3
CYN 3.5' 1.27
EP-01-042
AL 2' 260,000
CR 2' 29.7
5' 27.7
CU 2' 337
PB 2' 932
AG 2' 1.27
TL 2' 16.6
ZN 2' 131
CYN 2' 1.87
EP-01-044
AL 5 24,400
BA 5' 281
CR 5' 28.8
NI 5' 24.6
TL 5' 10.2
V 5' 41.6
CYN 5' 2.09
EP-01-073
PB 5.5' 83.7
TL 5.5' 19.5
ZN 5.5' 134
EP-01-040
CYN 8.5' 1.61
EP-01-039
EP-01-038
EP-01-037
EP-01-036
EP-01-041
CU 9' 33
HG 9' 0.077
TL 9' 11.9
EP-01-035
TL 6' 13.7
EP-01-032
NI 5' 24.2
EP-01-031
EP-01-033
AL 4 210,000
CR 4 36.6
CU 4 91.8
NI 4 25.7
6.5 24.7
AG 4 2.10
TL 4 14.1
6.5 10.2
V 6.5 39.7
EP-01-060
CU 2.5' 39.8
EP-01-043
TL 5.0 17.2
EP-01-047
TL 5' 12.3
EP-01-048
CYN 4.5 15.3
EP-01-049
CU 4.5' 56.6
EP-01-062
CD 2.5 1.96
CU 2.5' 215
MN 6 691
TL 6 10.7
ZN 2.5 328
EP-01-067
CD 4.5 1.51
CU 4.5' 213
EP-01-057
BA 5' 307
CD 2.5 3.39
CU 2.5 132
HG 2.5 0.126
5' 0.0706
EP-01-026
BA 4.5' 2440
7' 870
CD 4.5' 11.8
CU 4.5' 244
7' 95.7
HG 4.5' 0.132
AG 4.5' 0.763
ZN 4.5' 9300
7' 114
EP-01-009
CD 1.5' 16.5
4.5' 2.78
CU 1.5' 551
4.5' 69.6
PB 1.5' 586
4.5' 2470
AG 1.5' 0.671
ZN 1.5' 283
4.5' 196
ZN 4.5 777
SE 3.5' 2.42
AG 3.5 4.94
ZN 3.5' 404
CD 4.5' 32.5
CR 4.5' 33.6
CU 4.5' 3400
MN 4.5' 846
NI 4.5' 28.4
AG 4.5' 8.67
ZN 4.5' 12,000
4.5' 471
PB 2.5' 505
3.5' 11.3
HG 2 0.216
4.5' 0.214
NI 4.5' 23.6
ZN 2.5' 704
4.5' 238
2' 187
CYN 4.5' 1.70
EP-01-055
CD 5' 1.32
CU 2' 57.7
5' 2340
PB 5' 108
HG 2' 0.148
5' 0.0636
ZN 5' 1260
EP-01-056
CD 2' 1.74
4.5' 0.85
CU 2' 105
4.5' 74.5
CYN 2' 2.27
SB-01-002
AS 35' 18.0
CD 5' 1.06
CU 5' 111
CR 90' 27.4
HG 5' 0.098
15' 0.0585
35' 0.0677
ZN 5' 161
SB 100' 11.7
EP-01-058
CD 3' 1.69
5' 1.86
CU 3' 115
5' 133
CYN 3' 1.06
5' 1.92
EP-01-066
CD 3' 2.18
5 1.92
CR 5 71.7
CU 3' 191
5' 140
HG 3' 0.0563
5 0.0570
NI 5' 38.2
TL 5' 33.0
CYN 5 2.03
EP-01-068
CD 3' 1.90
5' 1.77
CU 3' 142
5' 180
HG 5' 0.08
EP-01-069
CD 3.5' 1.49
5.5' 1.18
CU 3.5 108
5.5' 98
HG 5.5' 0.0929
EP-01-061
CD 4.5' 1.98
CU 4.5' 199
ZN 4.5' 245
CYN 4.5' 1.60
EP-01-076
CD 5.5' 0.897
CU 5.5' 160
HG 5.5' 0.103
ZN 5.5' 117
EP-01-070
CD 3' 1.84
5' 3.07
CU 3' 99.0
5' 114
HG 3 0.0902
5' 0.0838
EP-01-063
TL 5' 15.8
CYN 5' 1.44
EP-01-071
CD 2.5 3.84
5.5' 1.76
CU 2.5' 154
5.5' 63
PB 5.5' 130
HG 2.5' 0.068
5.5' 0.102
EP-01-046
AL 3' 64,000
TL 3' 18.1
4.5 14.9
CYN 3' 3.05
4.5' 2.52
EP-01-064
TL 5' 12.9
EP-01-065
TL 4.5' 14.6
EP-01-081
TL 5.5' 17.9
EP-01-077
NI 4.5' 25.6
TL 4.5' 26.9
EP-01-078



Source: *Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.*

EXPLANATION

- ● Test pit location
- ◉ Deep soil boring location
- Access roadway
- Elevation contour line
- Intermittent stream bed

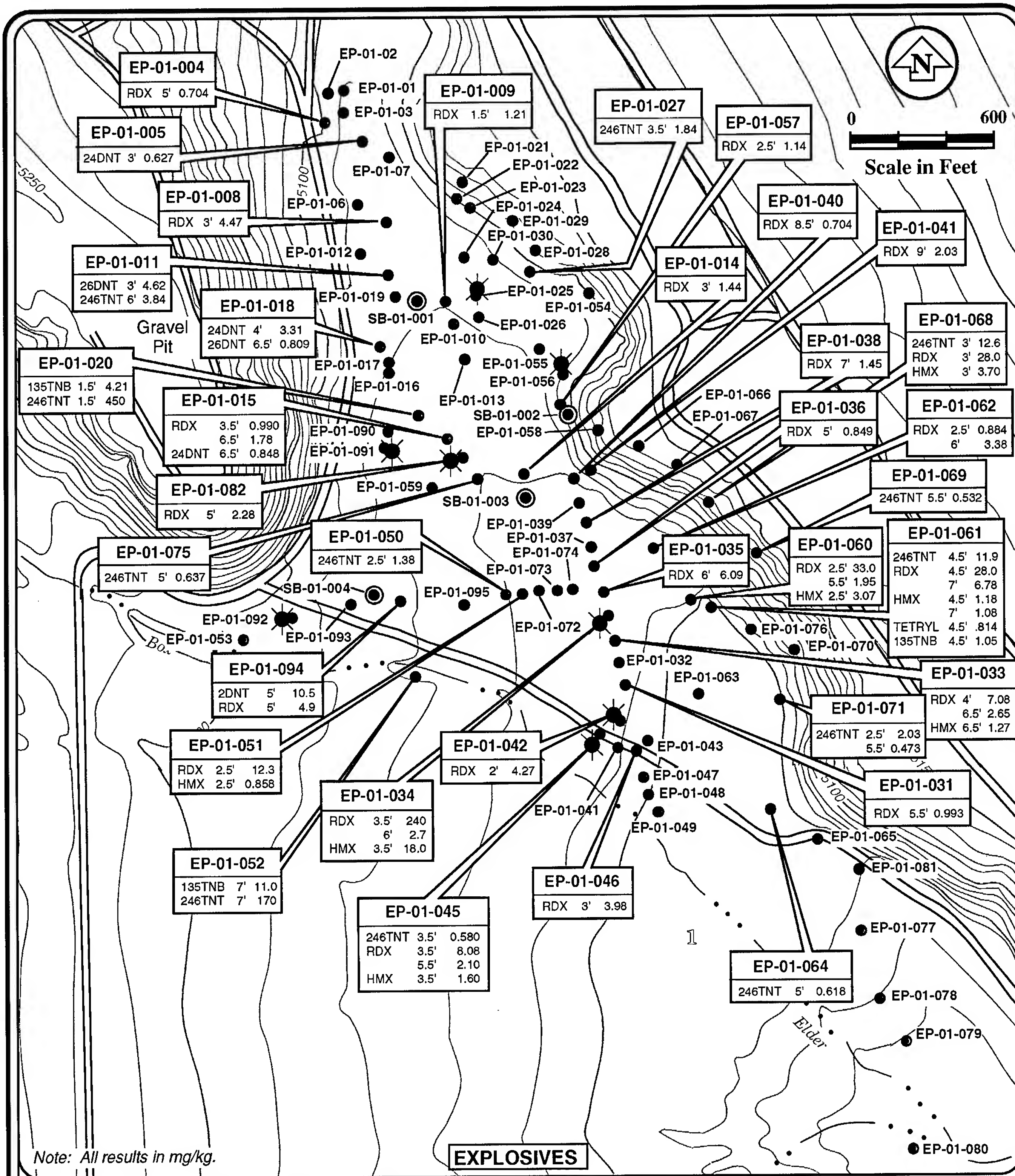
All results in mg/kg.

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
MAIN DEMOLITION AREA—SWMU 1, 1a
ANALYTICAL RESULTS FOR SUBSURFACE SOIL SAMPLES

FIGURE 5-5

(3)



Source: Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.

EXPLANATION

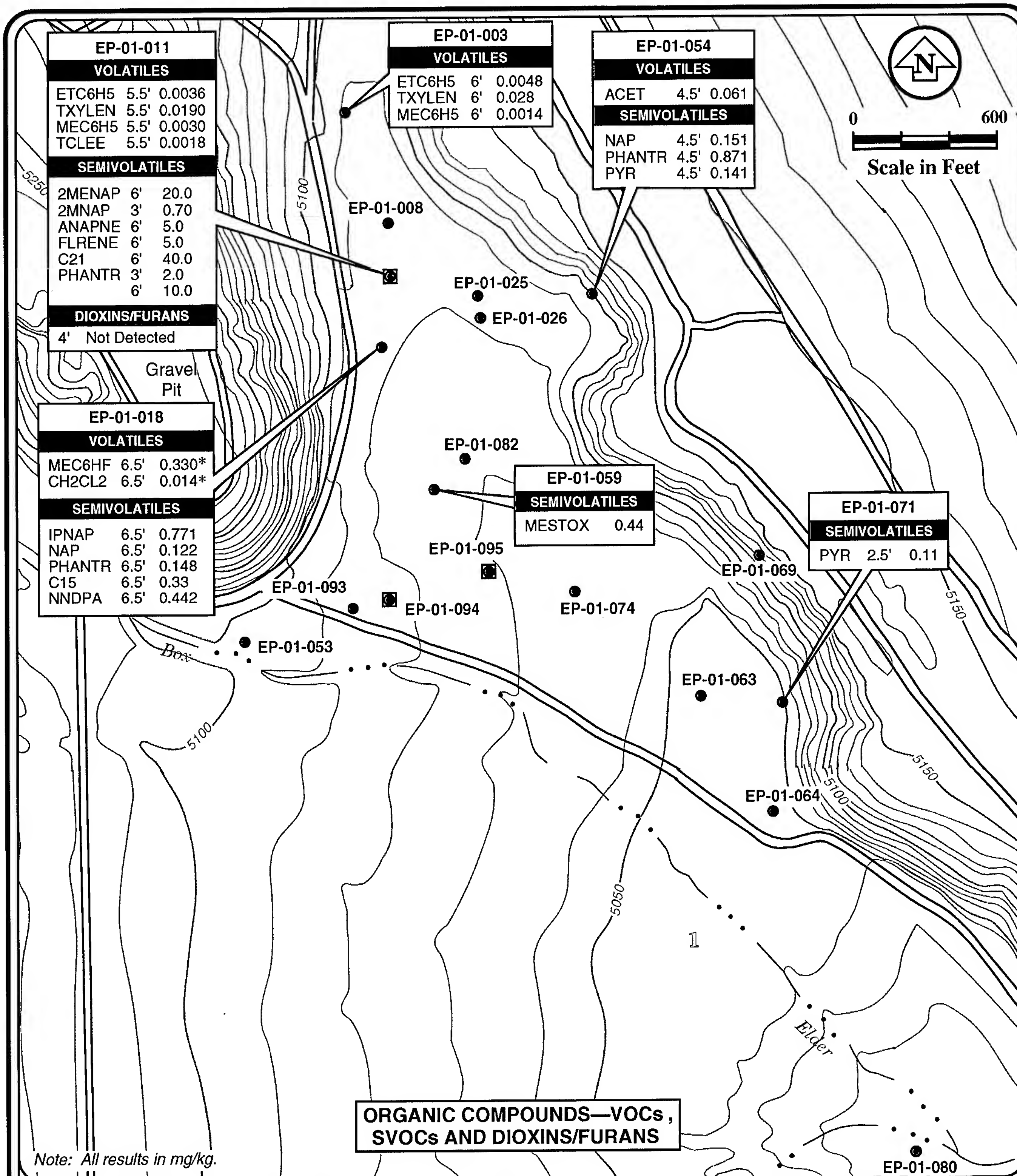
- Test pit location
- Deep soil boring location
- Explosive reactivity sample location
- Access roadway
- 5050 Elevation contour line
- Intermittent stream bed

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA

MAIN DEMOLITION AREA—SWMU 1, 1a
ANALYTICAL RESULTS FOR SUBSURFACE SOIL SAMPLES

FIGURE 5-6

PROJECT NO. 2942.0190 6/10/96



Source: *Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.*

EXPLANATION

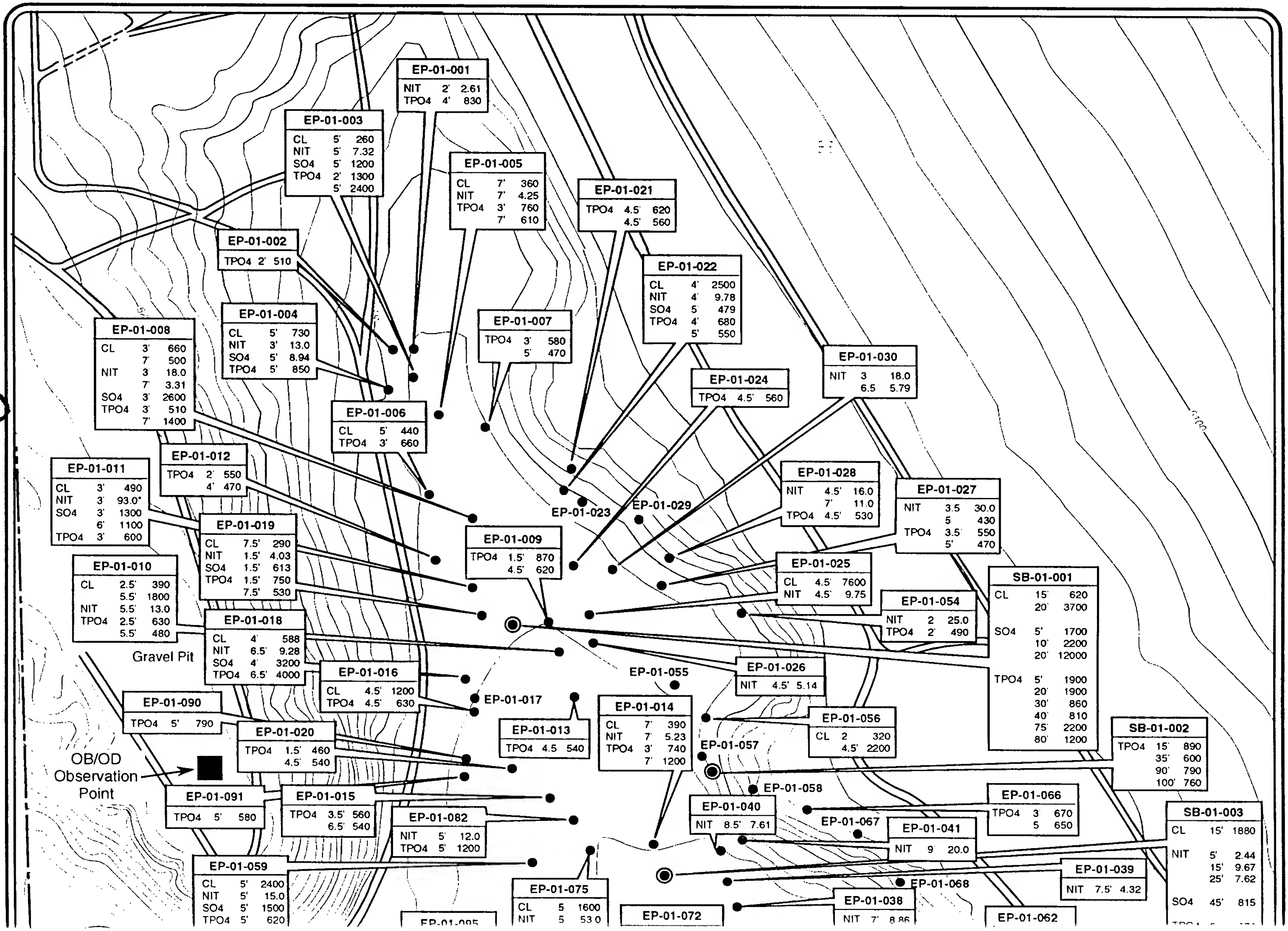
- ● Test pit sampled for VOCs/SVOCs
- ◼ Test pit sampled for dioxins/furans
- * *Data considered estimated. Refer to Appendix E.*
- Access roadway
- 5050 Elevation contour line
- • • • Intermittent stream bed

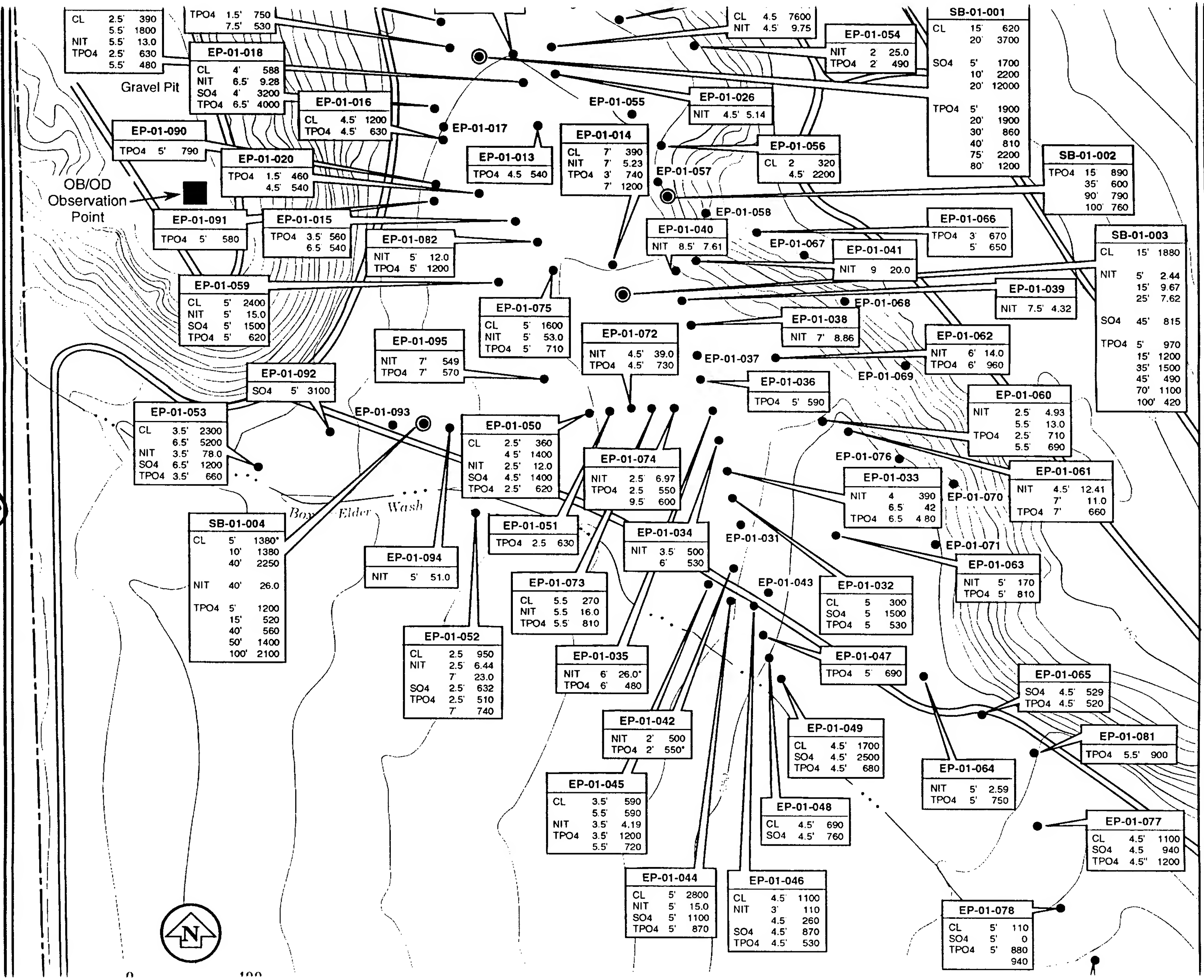
MONTGOMERY WATSON

TEAD-N PHASE I RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
MAIN DEMOLITION AREA—SWMU 1, 1a
ANALYTICAL RESULTS FOR SUBSURFACE SOIL SAMPLES
FIGURE 5-7

PROJECT NO. 2942.0190 10/23/95

PROJECT NO. 2942.0190





CL 2.5' 390 5.5' 1800 NIT 5.5' 13.0 TPO4 2.5' 630 5.5' 480
TPO4 1.5' 750 7.5' 530
EP-01-018
CL 4' 588 NIT 6.5' 9.28 SO4 4' 3200 TPO4 6.5' 4000
Gravel Pit
EP-01-016
CL 4.5' 1200 TPO4 4.5' 630
EP-01-090
TPO4 5' 790
EP-01-020
TPO4 1.5' 460 4.5' 540
OB/OD Observation Point
EP-01-091
TPO4 5' 580
EP-01-015
TPO4 3.5' 560 6.5 540
EP-01-082
NIT 5' 12.0 TPO4 5' 1200
EP-01-059
CL 5' 2400 NIT 5' 15.0 SO4 5' 1500 TPO4 5' 620
EP-01-092
SO4 5' 3100
EP-01-053
CL 3.5' 2300 6.5' 5200 NIT 3.5' 78.0 SO4 6.5' 1200 TPO4 3.5' 660
SB-01-004
CL 5' 1380* 10' 1380 40' 2250
NIT 40' 26.0
TPO4 5' 1200 15' 520 40' 560 50' 1400 100' 2100
Box Elder Wash
EP-01-093
EP-01-095
NIT 7' 549 TPO4 7' 570
EP-01-017
EP-01-013
TPO4 4.5 540
EP-01-014
CL 7' 390 NIT 7' 5.23 TPO4 3' 740 7' 1200
EP-01-075
CL 5' 1600 NIT 5' 53.0 TPO4 5' 710
EP-01-050
CL 2.5' 360 4.5' 1400 NIT 2.5' 12.0 SO4 4.5' 1400 TPO4 2.5' 620
EP-01-094
NIT 5' 51.0
EP-01-051
TPO4 2.5 630
EP-01-052
CL 2.5 950 NIT 2.5' 6.44 7' 23.0 SO4 2.5' 632 TPO4 2.5' 510 7' 740
EP-01-074
NIT 2.5' 6.97 TPO4 2.5 550 9.5' 600
EP-01-073
CL 5.5 270 NIT 5.5 16.0 TPO4 5.5' 810
EP-01-072
NIT 4.5' 39.0 TPO4 4.5' 730
EP-01-034
NIT 3.5' 500 6' 530
EP-01-035
NIT 6' 26.0* TPO4 6' 480
EP-01-042
NIT 2' 500 TPO4 2' 550*
EP-01-045
CL 3.5' 590 5.5' 590 NIT 3.5' 4.19 TPO4 3.5' 1200 5.5' 720
EP-01-044
CL 5' 2800 NIT 5' 15.0 SO4 5' 1100 TPO4 5' 870
EP-01-046
CL 4.5' 1100 NIT 3' 110 4.5' 260 SO4 4.5' 870 TPO4 4.5' 530
EP-01-048
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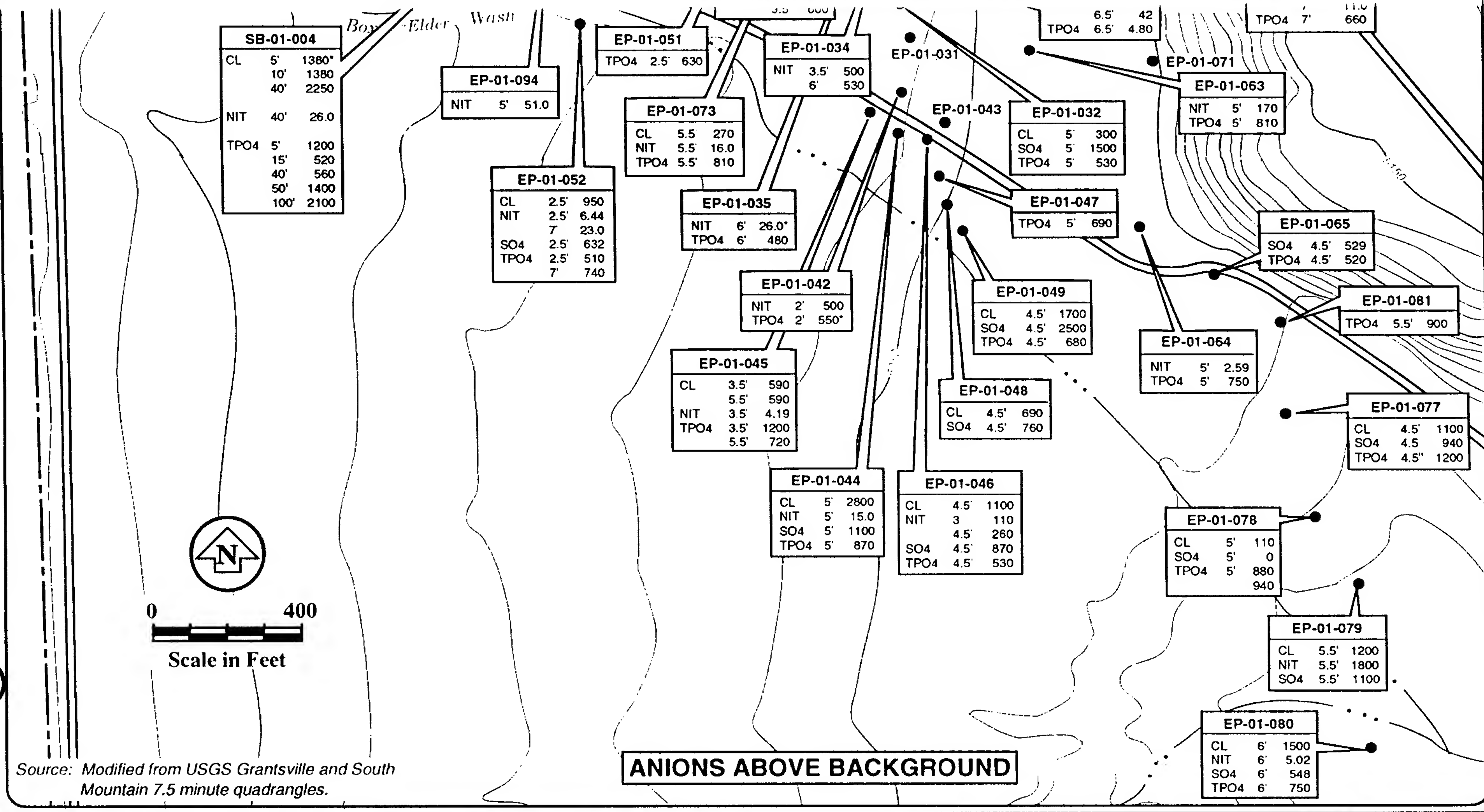
EP-01-049
CL 4.5' 1700 SO4 4.5' 2500 TPO4 4.5' 680
EP-01-047
TPO4 5' 690
EP-01-032
CL 5 300 SO4 5 1500 TPO4 5 530
EP-01-043
EP-01-031
EP-01-055
EP-01-026
NIT 4.5' 5.14
EP-01-056
CL 2 320 4.5' 2200
EP-01-057
EP-01-058
EP-01-040
NIT 8.5' 7.61
EP-01-067
EP-01-041
NIT 9 20.0
EP-01-066
TPO4 3' 670 5' 650
EP-01-068
EP-01-039
NIT 7.5' 4.32
EP-01-038
NIT 7' 8.86
EP-01-037
EP-01-062
NIT 6' 14.0 TPO4 6' 960
EP-01-069
EP-01-036
TPO4 5' 590
EP-01-060
NIT 2.5' 4.93 5.5' 13.0 TPO4 2.5' 710 5.5' 690
EP-01-076
EP-01-033
NIT 4 390 6.5' 42 TPO4 6.5 4.80
EP-01-070
EP-01-061
NIT 4.5' 12.41 7' 11.0 TPO4 7' 660
EP-01-071
EP-01-063
NIT 5' 170 TPO4 5' 810
EP-01-065
SO4 4.5' 529 TPO4 4.5' 520
EP-01-081
TPO4 5.5' 900
EP-01-064
NIT 5' 2.59 TPO4 5' 750
EP-01-077
CL 4.5' 1100 SO4 4.5 940 TPO4 4.5" 1200
EP-01-078
CL 5' 110 SO4 5' 0 TPO4 5' 880 940
CL 4.5 7600 NIT 4.5' 9.75
EP-01-054
NIT 2 25.0 TPO4 2' 490
SB-01-001
CL 15' 620 20' 3700
SO4 5' 1700 10' 2200 20' 12000
TPO4 5' 1900 20' 1900 30' 860 40' 810 75' 2200 80' 1200
SB-01-002
TPO4 15' 890 35' 600 90' 790 100' 760
SB-01-003
CL 15' 1880
NIT 5' 2.44 15' 9.67 25' 7.62
SO4 45' 815
TPO4 5' 970 15' 1200 35' 1500 45' 490 70' 1100 100' 420
N

(2)



Source: Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.

EXPLANATION

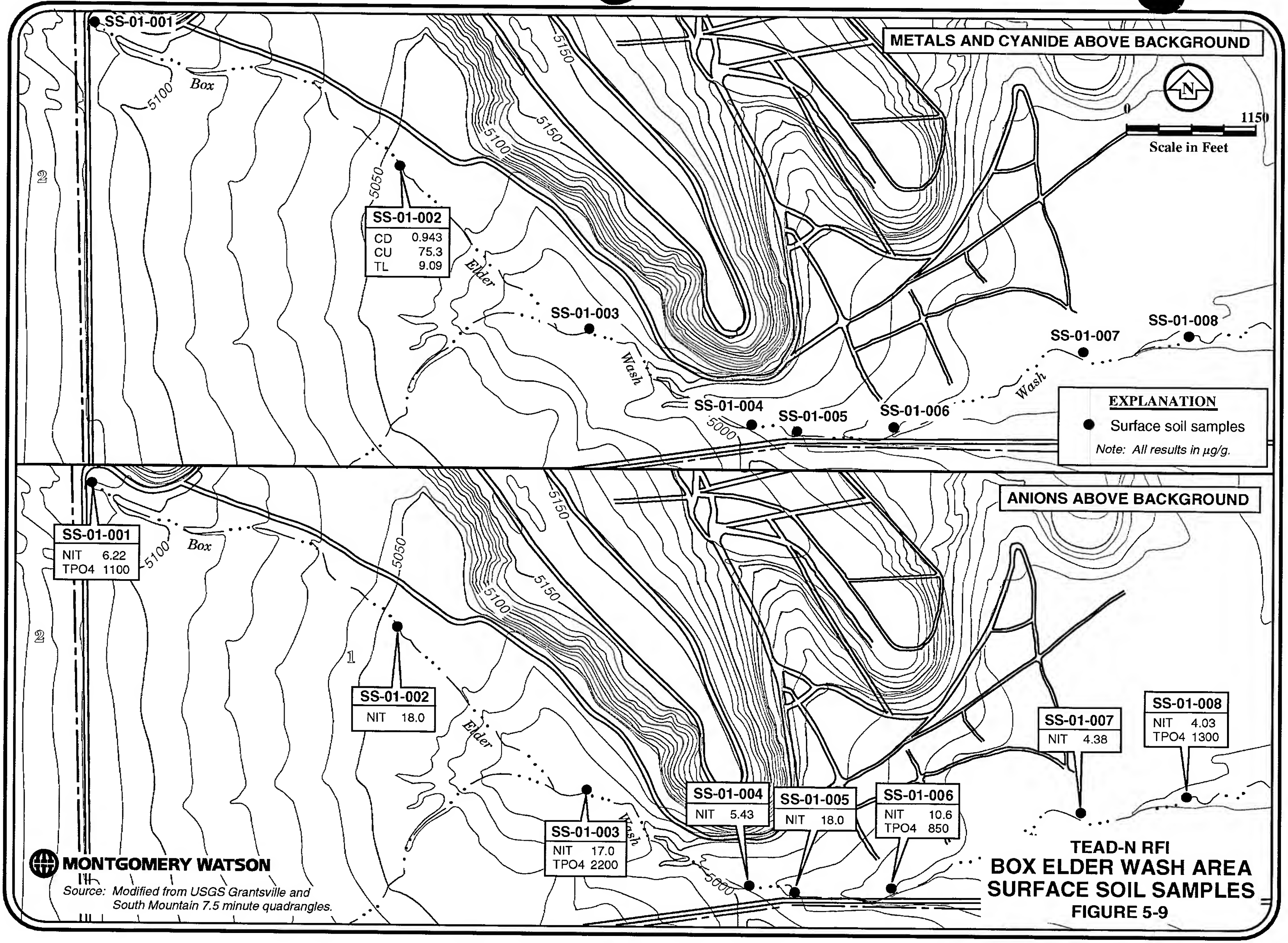
- Test pit location
- Deep soil boring location
- Access roadway
- 5050 Elevation contour line
- Intermittent stream bed

All results in mg/kg.

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
MAIN DEMOLITION AREA—SWMU 1, 1a
ANALYTICAL RESULTS FOR SUBSURFACE SOIL SAMPLES
FIGURE 5-8

3



TEAD-N RFI
BOX ELDER WASH AREA
SURFACE SOIL SAMPLES
FIGURE 5-9

5.3 CONTAMINATION ASSESSMENT

5.3.1. RFI Sampling Results

5.3.1.1. Surface Soils. Based on the results of the RFI sampling program, it appears a release of contaminants has occurred to the surface and shallow subsurface soils at the Main Demolition Area. As shown on Figure 5-2, metals above background levels were detected in almost all of the surface soil samples collected at SWMU 1. The most common metals detected above background in the surface soils included antimony (up to 162 mg/kg), barium (up to 1,730 mg/kg), cadmium (up to 92 mg/kg), copper (up to 100,000 mg/kg), lead (up to 68,000 mg/kg), thallium (up to 77 mg/kg), and zinc (up to 69,000 mg/kg). These results are not only above the SWMU 1 background values, but also above available soil risk-based guidance thresholds for residential and commercial/industrial scenarios (USEPA, 1994a). These guidance thresholds are used as initial screens for Superfund sites by USEPA Region III toxicologists, and are cited here only as a preliminary comparison. They are not intended as a stand-alone decision tool or a remediation goal.

5.3.1.2. Several explosives compounds were also detected in the surface soils, with 2,4,6-TNT, RDX, HMX, and 1,3,5-TNB being the most common (Figure 5-3). One or more explosive compounds were detected in 14 of the 38 surface soil samples submitted from the test pits. Explosives were found at all depths, but appear in the highest concentrations at the surface and near surface (down to 1 foot bgs).

5.3.1.3. Elevated levels of nitrates and total phosphates were found in the majority of the surface soil samples from SWMU 1 (Figure 5-4). Nitrate (up to 288 mg/kg) and total phosphate (up to 1,200 mg/kg) were detected. No surface soils from SWMU 1 were submitted for VOC, SVOC, or dioxins/furans analyses.

5.3.1.4. Subsurface Soils. Since test pit excavations were generally sited where aerial photographs identified pits or trenches, evidence of subsurface disposal and/or burning was found in most of the test pits excavated at SWMU 1. When found, these debris/disposal zones were preferentially sampled, and resulted in numerous elevated metal detections in the subsurface soils. Many of these detections are at concentrations between 1 and 10 percent, which is well above both the background thresholds for coarse-grained soils and available risk-based soil guidance thresholds (USEPA, 1994a). Figure 5-5 presents the subsurface metals results.

5.3.1.5. Detectable quantities of several explosives compounds were found in the subsurface soils across the Main Demolition Area, probably resulting from the extensive history of OB/OD disposal and demilitarization activities that have taken place. Figure 5-6 summarizes the analytical results of the explosives analyses for subsurface soils. Explosives were found at all depths, but appear in the highest concentrations at the surface and near-surface (down to 1 foot bgs). Elevated concentrations of 2,4-DNT, 2,4,6-TNT, RDX, HMX, and 1,3,5-TNB were found in subsurface soils; however, no explosives were detected in any of the deep soil borings and none of the explosive reactivity samples were determined to be reactive.

5.3.1.6. Both VOCs and SVOCs were detected in the subsurface soils at SWMU 1. Of the fifteen pits sampled for organic compounds, six contained detectable concentrations of VOCs and/or SVOCs (Figure 5-7). None of the VOCs or SVOCs exceeded available risk-based soil guidance thresholds (USEPA, 1994a). Localized contamination of soils by organic compounds at SWMU 1 may have been caused by the use of fuels for burning munitions, dunnage, or other items. One sample, selected from an area of burn residue at a depth of 4 feet bgs, was submitted for dioxins/furans analysis. None of these compounds were detected.

5.3.1.7. Elevated levels of all the major anions were detected in the subsurface soils, both in the test pits and the deep soil borings. Of these, only nitrate has an established risk-based soil guidance threshold (USEPA, 1994a). This threshold (130,000 mg/kg for residential soils) was not exceeded in samples from SWMU 1. Figure 5-8 presents the subsurface anions results.

5.3.1.8. Box Elder Wash. Based on the results of the Phase I RFI sampling along Box Elder Wash, no contamination of surface soils has occurred. The contaminants present at the various SWMUs at the OB/OD Area do not appear to have been transported by surface water runoff into or along this wash. As shown in Figure 5-9, the only metals detected above background thresholds were cadmium, copper, and thallium. These metals were detected above background thresholds in one out of eight samples only, and the concentrations of these metals are just slightly above the upper thresholds for background. No explosives were detected. The concentrations of major anions in some of the samples, while above the statistically-generated background values for facility soils, are not considered a concern here in the absence of other contaminants.

5.3.2. Nature and Extent of Contamination

5.3.2.1. The nature of contamination at the Main Demolition Area takes the form of widespread metals and explosives in surface soils and elevated metals and explosive compounds in subsurface soils where impacted by burial/disposal trenches. These burial/disposal trenches are present over a large part of the Main Demolition Area. Organic compounds are also present intermittently, but are of a lesser concern due to the generally low concentrations and limited extent. The lateral extent of the contamination has not been rigorously defined at this time, especially in the surface soils. Further environmental sampling at the time of OB/OD closure will be necessary to quantitatively define the lateral extent of contamination at SWMU 1.

5.3.2.2. Although contamination was found in the surface and shallow subsurface soils at SWMU 1, the results from the four 100-foot boreholes indicate that contaminants released from this SWMU do not extend to depth. The generally fine-grained, alkaline nature of the OB/OD Area soils probably tends to inhibit migration of contaminants. Vertical migration of contaminants is also minimized by the semi-arid climate present at TEAD-N, where amounts of precipitation are low and evaporation rates are high. These factors, and the depth to groundwater in this area (greater than 700 feet), make it unlikely that a threat to groundwater exists.

5.3.3. Selection of Chemicals of Potential Concern (COPCs) and Chemicals of Potential Ecological Concern (COPECs)

5.3.3.1. The selection of the COPCs for the Main Demolition Area (SWMU 1) was based on the screening procedures outlined in Section 3.2.6. A summary of all chemicals detected in soil samples from SWMU 1, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationale for the analytes not selected as COPCs is shown in Table 5-1.

5.3.3.2. Chemicals of potential concern selected for the human health risk assessment at SWMU 1 include the metals antimony, arsenic, barium, cadmium, chromium, lead, manganese, mercury, thallium, and zinc; and the explosives 1,3,5-TNB, 1,3-dinitrobenzene (DNB), 2,4,6-TNT, and RDX. The selection of COPCs was in accordance with the methodology outlined in Section 3.2.6.

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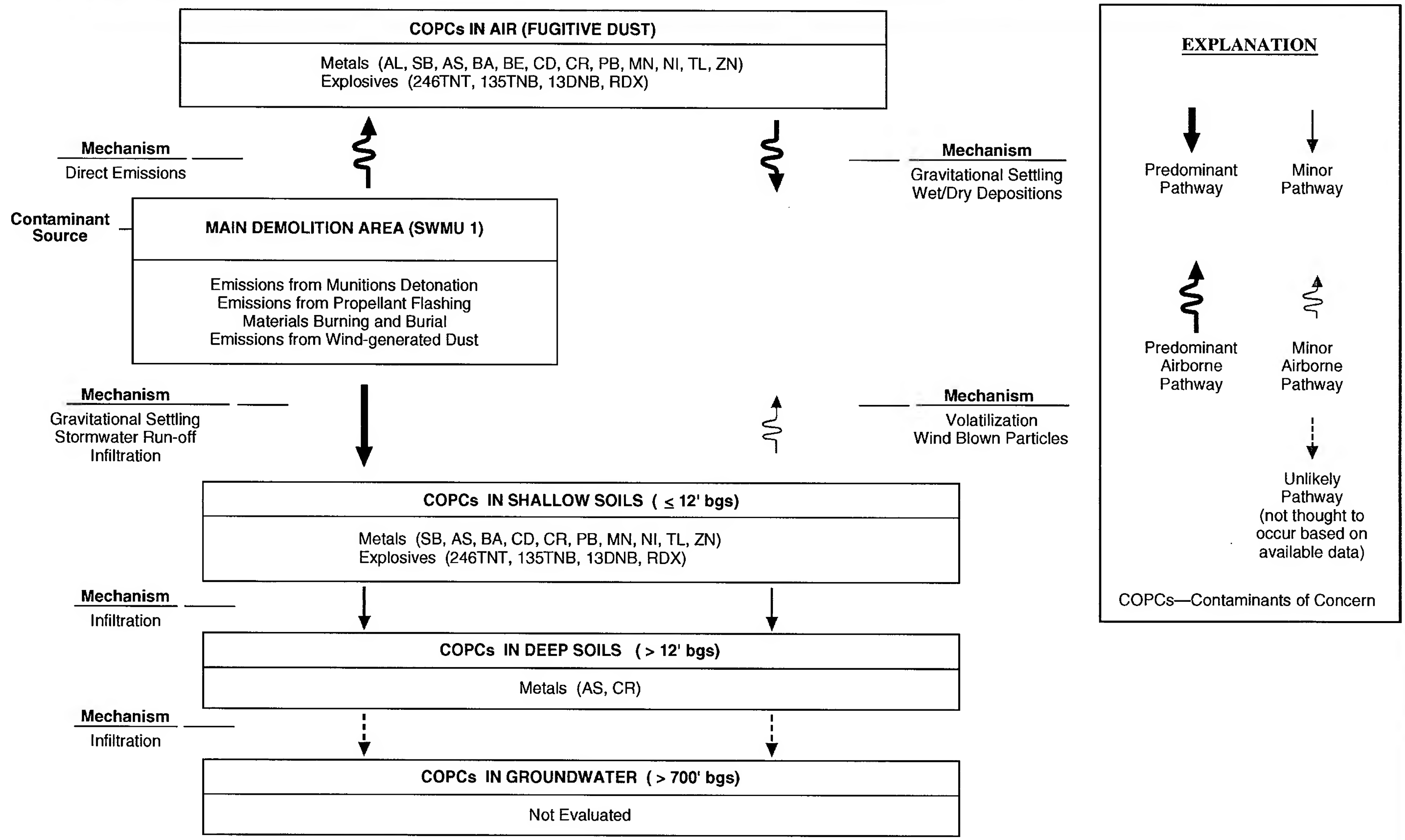

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
MAIN DEMOLITION AREA—SWMU 1
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 5-10

soil pH, and depth of groundwater (more than 700 feet below the ground surface), transport of metals from the surface soils through the deeper soil horizons to groundwater is not expected. Deep soil borings drilled to 100 feet bgs confirm that metals have not migrated deeper than approximately 10 feet bgs. Off-site migration of metals via the surface water pathway appears to be negligible, since soil samples collected down stream of the Main Demolition Area from Box Elder Wash detected no significant contamination. Metals present at the surface may provide particulates to the air pathway from this site. For this reason, the potential exposure of off-site residents at Grantsville to COPCs will be evaluated in the risk assessment section that follows.

5.3.4.4. Fate and Transport of Explosives. Explosive compounds in the environment are generally mobile; they tend to leach through soils and slowly volatilize from surface soils. Low concentrations of explosives were identified at SWMU 1; however, at one sample location (EP-01-043) concentrations up to 11,000 mg/kg in the surface soils and 450 mg/kg in subsurface soils were detected. At these elevated concentrations there could be a potential for leaching of explosives to deep soil horizons. However, soil samples collected from the deep soil borings indicate that explosives concentrations generally attenuate with depth, and no explosives were detected below 10 feet bgs. In addition, vadose zone contaminant transport modeling by Rust E&I, (1994) has shown that it would take over 100 years for these contaminants to migrate 300 vertical feet and the resulting concentration at that depth would be orders of magnitude less than the current concentrations in the soil. Groundwater at SWMU 1 is over twice this depth (greater than 700 feet bgs). Attenuation of the explosive concentrations in the surface soils would be expected through slow volatilization to the atmosphere or by slow photolytic transformations. Explosives in subsurface soils the may be attenuated by biodegradation.

5.4 HUMAN HEALTH RISK ASSESSMENT

5.4.1. Exposure Pathways and Receptors

5.4.1.1. The pathways quantitatively evaluated in the baseline risk assessment (BRA) are: (1) those that are complete or likely to be completed in the future, and (2) those that may potentially cause a significant risk. An evaluation of completeness is shown in Figure 5-11, which is an exposure pathway diagram for SWMU 1. An evaluation of pathway completeness and an assessment of whether the pathway is significant enough to require further evaluation for current and potential future receptors at SWMU 1 is given in Tables 5-2 and 5-3, respectively. Note that potential exposure pathways included in

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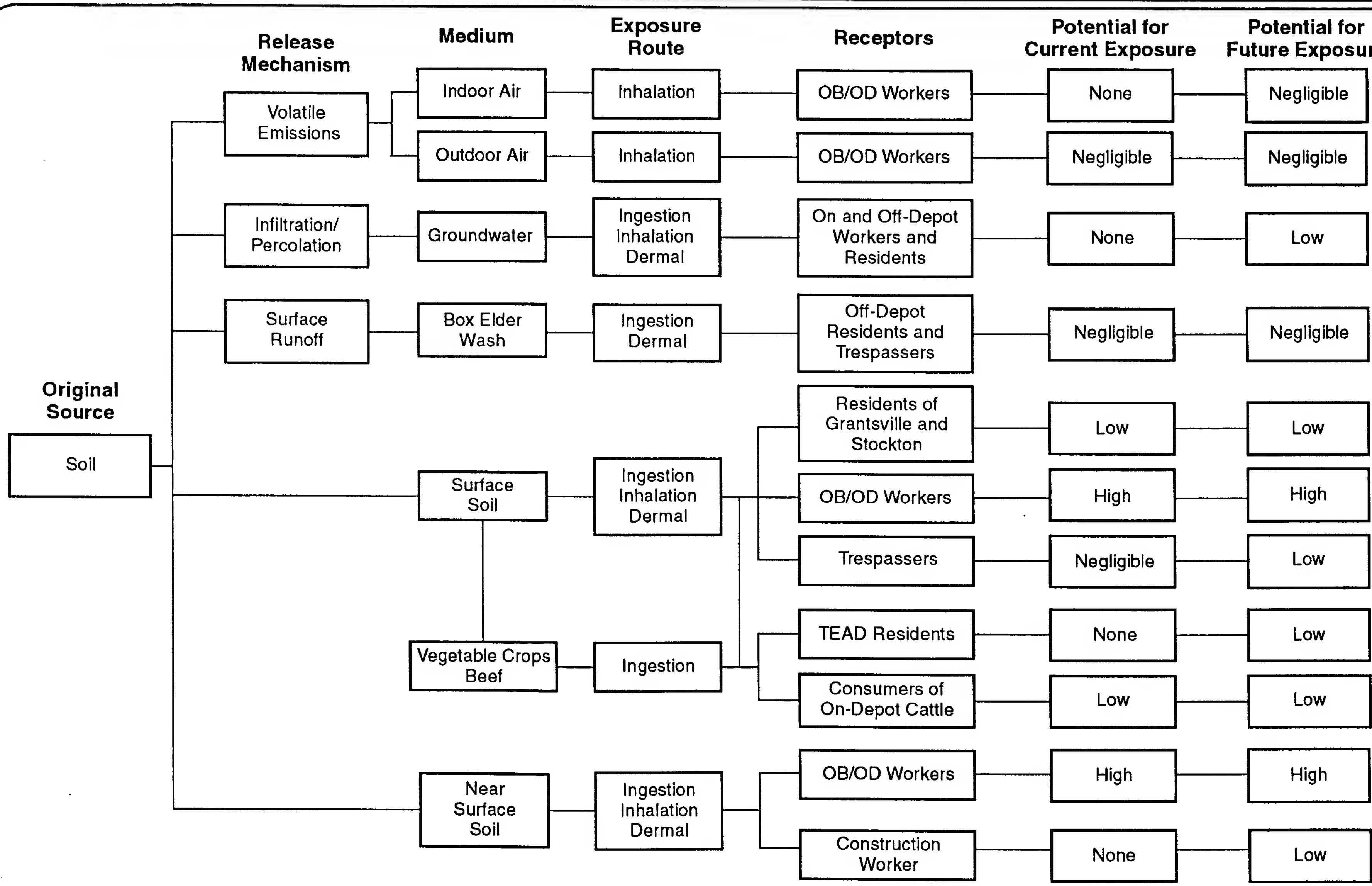


MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
MAIN DEMOLITION AREA—SWMU 1
EXPOSURE PATHWAYS DIAGRAM
FIGURE 5-11

TABLE 5-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 1: MAIN DEMOLITION AREA

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is greater than 700 feet below ground surface. Soil samples from 10 feet to the maximum depth explored of 100 feet below ground surface were not contaminated.
Surface Water and Sediment			
Box Elder Wash	Trespassers and off-Depot residents	Incidental ingestion and dermal contact with water or sediment	No. Only rarely is there water in the wash. Samples collected from Box Elder Wash were not contaminated.
Soil			
Surface Soil	Residents of Grantsville and Stockton	Inhalation of fugitive dust	Yes. The ground in the Main Demolition Area is disturbed regularly and the SWMU is a large source area for dust.
	Trespassers	Incidental ingestion, inhalation, and dermal contact with dust	No. There is no evidence, such as tracks or sightings, that trespassers are present on a frequent basis.
	Consumers	Ingestion of beef from cattle grazing in this SWMU	Yes. Cattle could take up contaminants directly from surface soil and from forage.
Near-Surface Soil	OB/OD workers	Incidental ingestion, inhalation, and dermal contact with dust	Yes. Near-surface soil is contaminated (also includes exposure to surface soil). Workers routinely rework the detonation pits.
Air	OB/OD workers	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure evaluated under soil.

OB/OD Open Burning/Open Detonation

TABLE 5-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 1: MAIN DEMOLITION AREA

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely to result in the future. Groundwater is over 700 feet below the below ground surface and pan evaporation is much higher than precipitation.
Surface Water and Sediment			
Box Elder Wash	Off-Depot workers and trespassers	Incidental ingestion, dermal contact with water or sediment	No. Only rarely is there water in the wash. Sediment samples collected from the wash were not contaminated.
Soil			
Surface Soil	Residents of Grantsville and Stockton	Inhalation of fugitive dust	No. Exposure will be the same as that evaluated under current conditions.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil contains elevated levels of chemicals and future residents must be evaluated in accordance with State of Utah regulations.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Exposure for trespassers will be much less than for residents.
Near-Surface Soil	OB/OD workers	Incidental ingestion of dust, inhalation, and dermal contact	No. Scenario is similar to the same pathway evaluated under current conditions.
	Construction worker	Incidental ingestion of dust, inhalation, and dermal contact	Yes. While future scenarios involving construction are unlikely because of the potential for unexploded ordnance, this pathway has been evaluated to provide a benchmark for contaminants in near surface soil.
Air	OB/OD workers	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure evaluated under soil.

OB/OD Open Burning/Open Detonation
TEAD-N Tooele Army Depot North Area

this BRA are limited to exposures to chemicals which have been released to the environment. This assessment does not address occupational exposure during open burning/open detonation operations.

5.4.1.2. Current on-Depot receptors include the civilian Depot personnel who conduct detonations at SWMU 1. Typically, one surveillance person and eight to twelve workers are associated with the open detonation operations. When operating full time, operations are conducted up to four days per week for eight months of the year. The number of detonations varies because they are conducted on an as-needed basis. Depot personnel excavate the pits where munitions are detonated and have direct contact with the soil at SWMU 1. Exposure routes include ingestion, dermal contact, and inhalation of dust.

5.4.1.3. Other current receptors include the residents of the depot housing in the eastern portion of the depot, and residents of Grantsville and Stockton. The depot housing is approximately 6.4 miles east of SWMU 1, and is only rarely downwind. Grantsville is located approximately five miles north of the Main Demolition Area and is frequently downwind of SWMU 1. Stockton is about 6.5 miles east southeast of SWMU 1, and is downwind less often. An evaluation was performed regarding the potential for residents of Grantsville and Stockton to inhale contaminated dust from SWMU 1.

5.4.1.4. Another currently complete pathway involves the uptake of soil contaminants into grass, and then to cattle that graze within SWMU 1 for four to six months per year. The cattle graze on the grass and incidentally ingest surface soil, and people subsequently eat the beef from these cattle.

5.4.1.5. Potential future on-Depot receptors for contaminants originating at SWMU 1 include construction workers. As shown in the exposure pathway diagram (Figure 5-11), construction workers can be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For future construction workers, direct exposure results from the anticipated excavation activities associated with construction, and includes subsurface soil as well as surface soil. Should this portion of the Depot be closed in the future (it is not slated for closure at this time), future residents could also become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. It should be noted that a residential development is unlikely even if the Depot is closed because SWMU 1 is in a remote area. However, because of the requirements of UAC 315-101 (1994), a residential scenario was evaluated.

5.4.1.6. SWMU 1 could be converted into an area where crops are grown. However, efforts to grow vegetables in soil from adjacent areas failed (Rust E&I, 1995). The experiments included soil from an area where there was no known release of hazardous chemicals. It was concluded that the salt content of the soil was "toxic", and that vegetables could not be grown without leaching salt from the soil. Although such activities are considered unlikely, this pathway is evaluated as part of the future residential scenario. For the pathways that were evaluated quantitatively (see Tables 5-2 and 5-3), site specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are given in Appendix K.

5.4.2. Risk Characterization

5.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 1. The methods for calculating the risks are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

5.4.2.2. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable, a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk in between these two values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects are possible. Adult blood lead levels between 10 and 15 micrograms per deciliter (µg/dl) is a benchmark range based on hypertension in adult males and transfer of lead from a pregnant mother to her fetus. For children, 10 µg/dl is the benchmark typically used by the EPA (USEPA, 1994). Section 3.2.6. presents a discussion of the calculation of blood lead concentrations for adults and children.

5.4.2.3. In addition to the calculated estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for current Depot personnel, and potential future construction workers and residents.

5.4.2.4. Depot Personnel. The current OB/OD workers are assumed to be exposed to COPCs in the soil from a depth of 0 to 2 feet. Because of the invasive activities of excavations and explosions, the OB/OD workers were assumed to be exposed to higher quantities of soil than a typical worker (the 480 mg/day default for a construction worker rather than the 50 mg/day default for a typical worker). The estimates of risk for current OB/OD workers are presented in Table 5-4.

5.4.2.5. The excess lifetime cancer risk for Depot personnel working at SWMU 1 was estimated to be 6×10^{-5}. Most of the cancer risk is from (in decreasing order) ingestion and dermal exposure to 2,4,6-TNT and RDX. This risk estimate has greater significance because the pathway is complete. Other factors tend to diminish the significance of the calculated cancer risk. The explosives 2,4,6-TNT and RDX are Class C (possible human) carcinogens. While these chemicals account for 90 percent of the cancer risk estimate, they may not actually be human carcinogens. If factors that tend to overestimate exposure such as the concentration of contaminated dust, the soil ingestion rate, the soil adherence factor, and the exposure duration are accounted for (see the discussion of uncertainties in Section 5.4.3.), it is likely that the cancer risk estimate would be between 1×10^{-6} and 1×10^{-5}. This is demonstrated by a risk estimate of 3×10^{-6} where the cancer risk estimate is based on central tendency exposure (CTE) parameters (see Table 5-5). If 2,4,6-TNT and RDX are not human carcinogens, the actual risk is probably less than 1×10^{-6}. The quantitative risk estimates and qualitative factors related to the risk estimates are summarized in Table 5-6.

5.4.2.6. The concentration of lead in the blood of Depot personnel at SWMU 1 was estimated to be 10.4 µg/dl (Table 5-4), which is within the benchmark range of 10 to 15 µg/dl where health effects are thought to occur. The total hazard index for Depot personnel working at SWMU 1 was estimated to be 10. Most of the hazard index is from ingestion and dermal exposure to 2,4,6-TNT, 1,3-DNB, and 1,3,5-TNB, and inhalation exposure to manganese. The explosive compounds have been detected at high concentrations, but only in a small percentage of samples. The potential for adverse effects is dependent upon the extent to which workers actually encounter soil contaminated with explosives. Manganese, with an exposure point concentration of 310 mg/kg, is at a concentration less than the average manganese concentration in the Western United States (Shacklette and Boerngen, 1984). If these workers are at risk from manganese exposure, then most workers in the Western United States that experience high levels of dust (such as construction workers) are at a similar or higher risk.

TABLE 5-4

SWMU 1 - MAIN DEMOLITION AREA
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR DEPOT PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	1.4E+01	NC	NC	2E-06	2E-06	3
Chromium (VI)	7.8E-01	NC	NC	6E-07	6E-07	1
2,4,6-Trinitrotoluene	6.9E+02	2E-05	8E-06	NC	3E-05	53
Cyclonite (RDX)	1.1E+02	1E-05	1E-05	NC	3E-05	44
Pathway Total		4E-05	2E-05	2E-06		
Percent of Total		63	34	3		
			Total Cancer Risk:		**6E-05**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	1.3E+01	1E-01	9E-02	NC	2E-01	2
Barium	2.6E+02	1E-02	2E-03	1E-01	1E-01	1
Cadmium	1.4E+01	4E-02	6E-03	NC	5E-02	<1
Chromium (VI)	7.8E-01	5E-04	4E-05	NC	5E-04	<1
Chromium (III)	1.5E+01	5E-05	1E-05	NC	6E-05	<1
Lead	3.4E+03	NA	NA	NA	NA	NA
Manganese	3.1E+02	7E-03	2E-03	1E+00	1E+00	11
Mercury	9.5E-02	1E-03	6E-05	6E-05	1E-03	<1
Thallium	9.0E+00	4E-01	3E-03	NC	4E-01	3
Zinc	4.5E+03	5E-02	1E-03	NC	5E-02	<1
1,3,5-Trinitrobenzene	9.3E+00	6E-01	2E-01	NC	8E-01	8
1,3-Dinitrobenzene	4.0E+01	1E+00	4E-01	NC	2E+00	16
2,4,6-Trinitrotoluene	6.9E+02	4E+00	1E+00	NC	6E+00	56
Cyclonite (RDX)	1.1E+02	1E-01	1E-01	NC	2E-01	2
Pathway Total		7E+00	2E+00	1E+00		
Percent of Total		66	22	12		
			Total Hazard Index:		**1E+01**	
		Blood Lead Concentration µg/dl (95th percentile):			**10.4**	

CR Cancer risk
HI Hazard index
NC Not calculated
NA Not applicable
RME Reasonable maximum exposure

TABLE 5-5

SWMU 1 - MAIN DEMOLITION AREA
CTE CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR DEPOT PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	1.4E+01	NC	NC	1E-07	1E-07	4
Chromium (VI)	7.8E-01	NC	NC	4E-08	4E-08	2
2,4,6-Trinitrotoluene	6.9E+02	1E-06	2E-07	NC	1E-06	54
Cyclonite (RDX)	1.1E+02	7E-07	4E-07	NC	1E-06	41
Pathway Total		2E-06	6E-07	1E-07		
Percent of Total		70	24	6		
			Total Cancer Risk:		**3E-06**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	1.3E+01	3E-02	1E-02	NC	4E-02	2
Barium	2.6E+02	3E-03	3E-04	5E-02	5E-02	2
Cadmium	1.4E+01	1E-02	9E-04	NC	1E-02	<1
Chromium (VI)	7.8E-01	1E-04	6E-06	NC	1E-04	<1
Chromium (III)	1.5E+01	1E-05	2E-06	NC	1E-05	<1
Lead	3.4E+03	NA	NA	NA	NA	NA
Manganese	3.1E+02	2E-03	3E-04	4E-01	4E-01	15
Mercury	9.5E-02	2E-04	9E-06	2E-05	3E-04	<1
Thallium	9.0E+00	9E-02	5E-04	NC	9E-02	4
Zinc	4.5E+03	1E-02	2E-04	NC	1E-02	<1
1,3,5-Trinitrobenzene	9.3E+00	1E-01	3E-02	NC	2E-01	7
1,3-Dinitrobenzene	4.0E+01	3E-01	7E-02	NC	4E-01	15
2,4,6-Trinitrotoluene	6.9E+02	1E+00	2E-01	NC	1E+00	52
Cyclonite (RDX)	1.1E+02	3E-02	2E-02	NC	5E-02	2
Pathway Total		2E+00	4E-01	4E-01		
Percent of Total		69	14	17		
			Total Hazard Index:		**3E+00**	

Blood Lead Concentration μg/dl (50th percentile):	**5.8**

CR Cancer risk
HI Hazard index
NC Not calculated
NA Not applicable
CTE Central tendency exposure

TABLE 5-6

TEAD-N BASELINE RISK ASSESSMENT
SWMU 1–MAIN DEMOLITION AREA PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (µg/dl)	Key Chemicals(a)
Depot Personnel					10.4	
Ingestion	Current likely	Medium/High	7	4×10^{-5}		Lead, manganese, 1,3-dinitrobenzene, 1,3,5-trinitrobenzene, 2,4,6-trinitrotoleuen, cyclonite (RDX)
Dermal	Current likely	High/Neutral-High	2	2×10^{-5}		
Inhalation	Current likely	High/High	1	2×10^{-6}		
Construction Workers					8.3	
Ingestion	Future unlikely	Medium/High	2	8×10^{-7}		Antimony, arsenic, manganese, 2,4,6-trinitrotoluene, cyclonite
Dermal	Future unlikely	High/Neutral-High	0.8	2×10^{-7}		
Inhalation	Future unlikely	High/High	3	3×10^{-7}		
TEAD-N Residents					25.0	
Ingestion	Future unlikely	Medium/High	30	5×10^{-5}		Lead, 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, cyclonite (RDX)
Dermal	Future unlikely	High/High	7	3×10^{-5}		
Inhalation	Future unlikely	High/High	0.8	5×10^{-7}		
Vegetable Crops	Future unlikely	High/High	100,000	4×10^{-1}		
Beef	Current likely	High/Neutral	0.1	3×10^{-9}		
Grantsville Residents						
Inhalation	Current likely	High/High	0.01	7×10^{-9}	NC	Barium, cadmium, manganese
Stockton Residents						
Inhalation	Current likely	High/High	0.005	3×10^{-9}	NC	Barium, cadmium, manganese
Depot Housing Residents						
Inhalation	Current likely	High/High	0.003	9×10^{-10}	NC	Barium, cadmium, manganese

NC Not calculated
TEAD-N Tooele Army Depot North Area
[illegible] Chemicals that contribute 10 percent or more to total carcino[illegible] risk or hazard index

5.2.4.7. An estimate of the hazard index using CTE parameters equaled 3 (Table 5-5), primarily as a result of exposure to explosive compounds. This analysis leaves unchanged the conclusion that the potential for adverse effects is dependent upon the extent to which workers come in contact with the low percentage of soil that contains high levels of explosives. In fact, none of the individual CTE hazard indices are greater than 1.0, suggesting that (as with the cancer risk estimate) total chronic risk is based on the possibly incorrect assumption of additivity.

5.4.2.8. The inhalation exposure pathway has not been fully accounted for in the hazard index due to the absence of inhalation reference doses for several of the COPCs. However, the exposure doses of most COPCs are in a range where adverse health effects are unlikely (see the discussion of uncertainties in Section 5.4.3.; Appendix K summarizes the exposure doses). One exception is zinc, where the exposure dose is high enough such that the potential for adverse effects cannot be ruled out. As a component of products such as dusting powders and other consumer products where there is inhalation exposure, there is not necessarily an expectation for effects either.

5.4.2.9. It should be noted that the hazard index is more applicable to a future worker who does not work with explosives. The potential for adverse effects for the people currently working at SWMU 1 is most appropriately evaluated in an occupational context through such standards as permissible exposure limits and threshold limit values.

5.4.2.10. Residents of Grantsville and Stockton. The residents of depot housing, Grantsville, and Stockton are assumed to be exposed to COPCs in fugitive dust originating from the surface soil (0 to 0.5 feet) from SWMU 1. The estimated excess lifetime cancer risks were estimated to be 7 x 10^{-9}, 3 x 10^{-9}, and 9 x 10^{-10} for residents of Grantsville, Stockton, and depot housing, respectively (see Table 5-7). Hazard indices of 0.01, 0.005, and 0.003 were calculated, although barium, mercury, and manganese were the only COPCs with inhalation reference doses. However, as in the case of the Depot worker, the exposure doses for other COPCs are in a range where adverse effects are not expected. Blood lead levels were not estimated for off-Depot residents because the concentration of lead in air from SWMU 1 was estimated to be 0.002 $\mu g/m^3$ in Grantsville, 0.007 $\mu g/m^3$ in Stockton, and 0.0005 $\mu g/m^3$ in depot housing, which are insignificant compared to the default air concentration in the model from all sources of 0.1 $\mu g/m^3$. No adverse health effects are expected in residents of Grantsville, Stockton, or depot housing as a result of dust emissions from SWMU 1.

TABLE 5-7

SWMU 1 - MAIN DEMOLITION AREA
CANCER RISK CURRENT RESIDENTS

Cancer Risk

Chemical	RME Concentration (mg/kg)	Inhalation Cancer Risk			Chemical Percent of Total CR
		Grantsville	Stockton	Depot Housing	
Cadmium	1.7E+01	7E-09	3E-09	9E-10	100
Total Cancer Risk:		**7E-09**	**3E-09**	**9E-10**	

Hazard Index (Child)

Chemical	RME Concentration (mg/kg)	Inhalation Hazard Index			Chemical Percent of Total HI
		Grantsville	Stockton	Depot Housing	
Barium	2.8E+02	1E-03	5E-04	4E-04	10
Lead	4.8E+03	NC	NC	NC	NC
Manganese	3.4E+02	9E-03	4E-03	3E-03	90
Mercury	8.6E-02	4E-07	2E-07	1E-07	<1
Total Hazard Index:		**1E-02**	**5E-03**	**3E-03**	

CR Cancer risk
HI Hazard index
NC Not calculated
NA Not applicable
RME Reasonable maximum exposure

5.4.2.11. Potential Construction Worker. Potential future construction workers are assumed to be exposed to COPCs in the soil from a depth of 0 to 12 feet during excavation activities. The estimated excess lifetime cancer risk was 1 x 10^{-6} (Table 5-8). Most of the cancer risk is from the ingestion and inhalation of arsenic, and the ingestion of 2,4,6-TNT and RDX. Arsenic is a Class A (known human) carcinogen which adds to the significance of the risk estimates, although its carcinogenicity was identified at very high exposure doses that may not be relevant here. Despite the presence of arsenic, site-related cancer risks are expected to be less than 1 x 10^{-6} for two reasons. First, arsenic was evaluated as a COPC, but may not actually be present above background levels. In the near-surface soil (0-12 feet), arsenic was detected at concentrations above the background threshold concentration of 16 mg/kg in only 5 of 201 soil samples, and at a maximum detected concentration of 29 mg/kg. Because the statistical background threshold is expected to be exceeded in five percent of the samples when a metal is at background concentrations, the calculated risk for a construction worker from arsenic (6 x 10^{-7}) is probably a background risk. The second reason to expect actual risks to be less than 1 x 10^{-6} is that likely overestimates in soil ingestion rates and dust concentrations (see Section 5.4.3.) indicate that more accurate estimates of these parameters would reduce the cancer risk to less than 1 x 10^{-6} regardless of the anthropogenic or non-anthropogenic nature of the source. The likelihood of this hypothesis is further suggested by a cancer risk estimate of 4 x 10^{-7} using CTE parameters (see Table 5-9).

5.4.2.12. The total hazard index for potential construction workers was estimated to equal 5, and the concentration of lead in blood was estimated to be 8.3 μg/dl (Table 5-8). The blood lead concentration is below the benchmark range of 10 to 15 μg/dl. The hazard index of 5 is dominated by ingestion and dermal exposure of 2,4,6-TNT and the inhalation of manganese in dust. Uncertainties in the exposure point concentration and ingestion rate make it likely that the hazard quotient has been overestimated, and the actual hazard index from ingestion and dermal exposure may be less than 1. An estimate of the hazard index using CTE parameters equaled 2 (Table 5-9), but primarily as the result of inhalation exposure to manganese. Manganese may not represent an actual risk for reasons described for the OB/OD workers. As is the case of the Depot worker and the residents of Grantsville, the inhalation pathway has not been fully quantified due to the absence of inhalation reference doses of several COPCs. The potential for adverse effects from the inhalation of chromium and zinc is unknown.

TABLE 5-8

SWMU 1 - MAIN DEMOLITION AREA
RME CANCER RISK AND HAZARD INDEX FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	6.8E+00	4E-07	4E-09	1E-07	6E-07	44
Cadmium	7.4E+00	NC	NC	6E-08	6E-08	5
Chromium (VI)	1.3E+00	NC	NC	7E-08	7E-08	6
2,4,6-Trinitrotoluene	2.2E+02	2E-07	7E-08	NC	3E-07	24
Cyclonite (RDX)	3.7E+01	1E-07	1E-07	NC	3E-07	21
Pathway Total		8E-07	2E-07	3E-07		
Percent of Total		61	16	23		
			Total Cancer Risk:		**1E-06**	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	5.9E+01	3E-01	3E-01	NC	7E-01	13
Arsenic	6.8E+00	5E-02	5E-04	NC	5E-02	1
Barium	7.3E+02	2E-02	4E-03	7E-02	1E-01	2
Cadmium	7.4E+00	2E-02	2E-03	NC	2E-02	0
Chromium (VI)	1.3E+00	2E-04	1E-05	NC	2E-04	<1
Chromium (III)	2.5E+01	6E-05	1E-05	NC	7E-05	<1
Lead	2.3E+03	NC	NC	NC	NA	NA
Manganese	3.7E+02	6E-03	2E-03	3E+00	3E+00	50
Mercury	5.8E-02	5E-04	3E-05	7E-05	5E-04	0
Thallium	9.1E+00	3E-02	2E-04	NC	3E-02	1
Zinc	1.9E+03	1E-02	4E-04	NC	2E-02	0
1,3,5-Trinitrobenzene	3.2E+00	1E-01	5E-02	NC	2E-01	4
1,3-Dinitrobenzene	1.3E+01	3E-02	1E-02	NC	4E-02	1
2,4,6-Trinitrotoluene	2.2E+02	1E+00	3E-01	NC	1E+00	27
Cyclonite (RDX)	3.7E+01	3E-02	3E-02	NC	5E-02	1
Pathway Total		2E+00	8E-01	3E+00		
Percent of Total		34	15	51		
				Total Hazard Index:	**5E+00**	
		Blood Lead Concentration µg/dl (95th percentile):			**8.3**	

CR Cancer risk
HI Hazard index
NC Not calculated
NA Not applicable
RME Reasonable maximum exposure

TABLE 5-9

SWMU 1 - MAIN DEMOLITION AREA
CTE CANCER RISK AND HAZARD INDEX FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	6.8E+00	1E-07	6E-10	6E-08	2E-07	47
Cadmium	7.4E+00	NC	NC	3E-08	3E-08	7
Chromium (VI)	1.3E+00	NC	NC	3E-08	3E-08	8
2,4,6-Trinitrotoluene	2.2E+02	6E-08	1E-08	NC	7E-08	21
Cyclonite (RDX)	3.7E+01	4E-08	2E-08	NC	6E-08	17
Pathway Total		2E-07	4E-08	1E-07		
Percent of Total		59	10	31		
			Total Cancer Risk:		4E-07	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	5.9E+01	1E-01	5E-02	NC	2E-01	9
Arsenic	6.8E+00	1E-02	8E-05	NC	1E-02	1
Barium	7.3E+02	7E-03	8E-04	3E-02	4E-02	2
Cadmium	7.4E+00	5E-03	4E-04	NC	5E-03	0
Chromium (VI)	1.3E+00	4E-05	2E-06	NC	5E-05	<1
Chromium (III)	2.5E+01	2E-05	2E-06	NC	2E-05	<1
Lead	2.3E+03	NC	NC	NC	NA	NA
Manganese	3.7E+02	2E-03	3E-04	1E+00	1E+00	61
Mercury	5.8E-02	1E-04	5E-06	3E-05	2E-04	0
Thallium	9.1E+00	7E-03	4E-05	NC	8E-03	0
Zinc	1.9E+03	4E-03	8E-05	NC	4E-03	0
1,3,5-Trinitrobenzene	3.2E+00	4E-02	9E-03	NC	5E-02	3
1,3-Dinitrobenzene	1.3E+01	8E-03	2E-03	NC	1E-02	1
2,4,6-Trinitrotoluene	2.2E+02	3E-01	6E-02	NC	3E-01	21
Cyclonite (RDX)	3.7E+01	8E-03	5E-03	NC	1E-02	1
Pathway Total		5E-01	1E-01	1E+00		
Percent of Total		29	8	63		
				Total Hazard Index:	2E+00	
		Blood Lead Concentration µg/dl (50th percentile):			4.7	

CR Cancer risk
HI Hazard index
NC Not calculated
NA Not applicable
CTE Central tendency exposure

5.4.2.13. Potential Future TEAD-N Resident. Potential future residents at TEAD-N were assumed to be exposed to COPCs in the soil from a depth of 0 to 0.5 feet. The cancer risk from all exposure pathways was estimated to equal 4 x 10^{-1}, and the hazard index was estimated to equal 100,000. The excess lifetime cancer risk from potential exposure to soil was estimated to be 8 x 10^{-5} (Table 5-10). Most of the cancer risk is from ingestion and dermal exposure to 2,4,6-TNT and RDX. The explosives 2,4,6-TNT and RDX are Class C (possible human) carcinogens. The lack of evidence that these compounds are human carcinogens and the conservative exposure assumptions cause a large degree of uncertainty in the risk estimates.

5.4.2.14. The total hazard index for potential future child residents exposed to soil at TEAD-N was approximately 40 and the estimated blood lead concentration was 25.0 µg/dl. The blood lead concentration is higher than the minimum at which effects have been observed in children. The dose-response effects of exposure to lead are fairly well documented and the risk estimate is enough greater than the minimum effects level that the potential for adverse effects must be considered even taking into account uncertainties in the intake parameters. The hazard index of 40 is dominated by ingestion and dermal exposure to 2,4,6-TNT. After accounting for overestimates in exposure parameters, the hazard index would probably still exceed 1. However, the significance of the residential risk estimates is diminished because the potential for this pathway to be completed is low.

5.4.2.15. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 1, the estimated cancer risk is 4 x 10^{-1} and the hazard index is 100,000 (Table 5-10) primarily due to the explosives 2,4,6-TNT, 1,3,5-TNB, and RDX. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has several orders of magnitude of uncertainty because of uncertainties in the plant uptake factors (see Section 5.4.3.). If plants metabolize explosives (which is not accounted for in the uptake model), the risks from the explosives via this pathway would be low. Because of the high degree of uncertainty associated with this pathway, the significance of these risk estimates is unknown.

5.4.2.16. Exposure Through Beef. The ingestion of beef from cattle grazing at SWMU 1 resulted in a cancer risk of 3 x 10^{-9} and a hazard index of 0.1 (Table 5-10). Unlike the other components of the residential scenario, ingestion of contaminants through beef is a current route of exposure. The scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at

TABLE 5-10

SWMU 1 - MAIN DEMOLITION AREA
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	1.7E+01	NC	NC	5E-07	NC	NC	5E-07	<1
2,4,6-Trinitrotoluene	8.8E+02	4E-05	2E-05	NC	3E-01	2E-09	3E-01	63
Cyclonite (RDX)	5.2E+01	9E-06	1E-05	NC	2E-01	2E-10	2E-01	37
Pathway Total		5E-05	3E-05	5E-07	4E-01	3E-09		
Percent of Total		<1	<1	<1	100	<1		
					Total Cancer Risk:		**4E-01**	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	1.6E+01	5E-01	3E-01	NC	3E+00	9E-04	4E+00	<1
Barium	2.8E+02	5E-02	7E-03	8E-02	3E-01	1E-05	4E-01	<1
Cadmium	1.7E+01	2E-01	2E-02	NC	4E+00	1E-04	5E+00	<1
Lead	4.8E+03	NC	NC	NC	NC	NC	NC	NC
Manganese	3.4E+02	3E-02	7E-03	7E-01	3E-01	2E-05	1E+00	<1
Mercury	8.6E-02	4E-03	2E-04	3E-05	1E-02	2E-06	2E-02	<1
Thallium	1.1E+01	2E+00	1E-02	NC	2E-01	8E-02	2E+00	<1
Zinc	6.4E+03	3E-01	6E-03	NC	NC	3E-02	3E-01	<1
1,3,5-Trinitrobenzene	1.1E+01	3E+00	7E-01	NC	2E+04	8E-05	2E+04	17
1,3-Dinitrobenzene	3.4E-01	4E-02	1E-02	NC	2E+02	2E-06	2E+02	<1
2,4,6-Trinitrotoluene	8.8E+02	2E+01	6E+00	NC	1E+05	1E-03	1E+05	81
Cyclonite (RDX)	5.2E+01	2E-01	1E-01	NC	3E+03	5E-06	3E+03	2
Pathway Total		3E+01	7E+00	8E-01	1E+05	1E-01		
Percent of Total		<1	<1	<1	100	<1		
					Total Hazard Index:		**1E+05**	
			Blood Lead Concentration µg/dl (95th percentile):				**25**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure
TEAD-N Tooele Army Depot North Area

SWMU 1 if they purchase their meat at a market, and their exposure will consequently be much lower. Cattle exposure to SWMU 1 contaminants will also be low because a large percentage of SWMU 1 is disturbed and barren of vegetation, and therefore, cattle grazing in the area will only get a small portion of their diet from this SWMU. In addition, while this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. The COPCs that are elevated over a large portion of SWMU 1 include RDX, zinc, and lead. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

5.4.3. Uncertainties

5.4.3.1. The exposure estimates and toxicity values have associated uncertainties. The magnitude and nature of these uncertainties affect the degree of confidence in the results. Most of the uncertainties are such that risk estimates could be lower, but are unlikely to be higher than estimated. The following paragraphs discuss uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor. These discussions are focused on elements contributing most to overestimates of the total risk, and on those elements where risks may be underestimated. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk.

5.4.3.2. The exposure point concentrations (concentrations of chemicals in an environmental medium at the point where a receptor is exposed) used in the risk calculations were based in part on judgmental sampling. Where observed, samples were collected from immediately below stained soil or within debris zones where munitions were burned or detonated. Because areas of burning/detonation occupy only a portion of this SWMU, and because samples collected from stained areas and zones of debris and ash would tend to be more contaminated than typical soil from this area, the exposure point concentrations are representative of the most contaminated areas, rather than the SWMU as a whole.

5.4.3.3. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been

documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions may occur.

5.4.3.4. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical with a reference dose below 1×10^{-6} mg/kg/day, thus this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation of metals with exposure doses greater than 1×10^{-6} was examined on a case-by-case basis. The results of this evaluation are presented in Section 5.4.2. Exposure doses are summarized in Appendix K.

5.4.3.5. Depot Personnel. Uncertainties for Depot personnel generally overestimate potential risks. These overestimates are related to factors such as the exposure duration and the concentration of contaminated dust. The greatest uncertainty for the Depot worker is the concentration of respirable dust and the soil ingestion rate. A dust concentration of 1 mg/m^3 was assumed for SWMU 1, and is higher than the concentration (0.05 mg/m^3) assumed at most of the other SWMUs because the soil is routinely disturbed during burning and detonation activities. This dust level was based on the upper end of the range of dust levels measured while digging test pits, which should be analogous to activities used to prepare the munitions. Most of the time, the measured dust levels were one to two orders of magnitude lower than the 1 mg/m^3 concentration used in the risk assessment.

5.4.3.6. While the assumption that a Depot worker ingests 480 milligrams of soil per day is a standard default value (USEPA, 1991b), it is based on an assumption that people ingest soil adhered to their skin while eating and that soil adheres to skin with a density of 3.5 mg/cm^2 (Hawley, 1985). More recent studies have shown that 1.0 mg/cm^2 is a

more appropriate skin adherence rate (USEPA, 1992), and therefore the soil ingestion rate is probably an overestimate by a factor of 3.5.

5.4.3.7. Dermal exposure uncertainties are associated with the amount of skin covered with soil, and the fraction of contaminant absorbed through the skin. While estimates of the area of exposed skin are fairly realistic, it is likely that less than 100 percent of the exposed skin becomes covered with soil. Consequently, the assumed area of exposure (i.e., the skin surface area in contact with soil) will be an overestimate. The fraction of chemicals absorbed from soil through the skin has been measured in only a few studies. The studies which have been performed generally did not include the COPCs in this BRA. The actual fraction absorbed could be higher or lower than assumed. This is most important for organic chemicals, as metals are thought to be poorly absorbed (USEPA, 1992).

5.4.3.8. Residents of Depot Housing, Grantsville, and Stockton. The inhalation of fugitive dust in Grantsville and Stockton originating from the Main Demolition Area was analyzed conservatively. In particular, the presence of hills immediately north of SWMU 1 (i.e., in between SWMU 1 and Grantsville) and east of SWMU 1 (i.e., between SWMU 1 and Stockton) were not accounted for in the air modeling. The effect of these hills will be to block much of the dust. The dust levels generated were based on the assumption that a truck drives the length of the SWMU twice per day, and breaks up the soil enough to allow substantial amounts of dust to be generated. Based on the location of the burns and detonations, a smaller amount of soil will typically be disturbed.

5.4.3.9. Construction Worker. Uncertainties associated with the exposure dose for a construction worker are generally similar to the OB/OD workers, as the exposure assumptions were generally the same. One exception is the exposure duration of one year, which is more common than the 25 years assumed for an OB/OD worker. Dermal risks may not be an overestimate for organic compounds if the assumed fraction of COPCs absorbed through the skin is an underestimate. However, because of likely overestimates in the exposure point concentration and the area of exposed skin covered with contaminated soil, dermal exposure has probably not been underestimated.

5.4.3.10. Residents. The uncertainties for construction and Depot workers are also reflected in the evaluation of future TEAD-N residents, although the magnitude of the uncertainties differs. In a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure, and (to a

lesser extent) reduces the potential for dermal and ingestion exposure. As in the case of the workers, uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the assumed dust level. Dermal uncertainties are derived from the assumed skin surface area covered with contaminated dust and the fraction of chemicals absorbed. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who directly eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate exceeds the assumed rate of 200 mg/day.

5.4.3.11. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

5.4.3.12. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53.

5.4.3.13. There is even greater uncertainty at SWMU 1. The estimated risks for the produce exposure pathway are dominated by RDX and 2,4,6-TNT. However, the equation used to estimate the plant uptake factors from the log K_{ow} was developed using mostly data for pesticides, which are very different from explosives; a poorer fit would be expected for explosives than for compounds used to develop the relationship. The plant uptake model also does not account for metabolism of the chemical by the plant. Based on their polar structure, it would not be surprising if plants metabolize RDX and 2,4,6-TNT, thus eliminating exposure to explosives by humans through this pathway. In addition, because the salt content of the soil is currently toxic to plants (see Section 5.4.1.6.), the soil would need to be diluted with peat or other soil amendments to grow produce. This has not been accounted for in the exposure calculations. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

5.4.4. Recommendations

5.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Continue to restrict access to the Main Demolition Area to ordnance personnel employed by TEAD-N

- Prohibit building construction in this SWMU

- Re-evaluate contamination and potential risks upon facility closure.

5.5 ECOLOGICAL RISK ASSESSMENT

5.5.0.1. This section discusses the results of the Tier 1 and Tier 2 ecological evaluations. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-4. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-5.

5.5.1. Tier 1

5.5.1.1. Ecological Receptors. A large percentage of SWMU 1 is disturbed and barren of vegetation due to the open burning and open detonation activities. Weed species, predominantly Russian thistle, rubber rabbitbrush, matchweed, gumweed, annual sunflower, and cheatgrass, have revegetated portions of the disturbed areas. The weed species are sparse and relatively small due to the frequent ground disturbances and the resultant water stress caused by a reduced water holding capacity. Near the perimeter of SWMU 1, flixweed, storksbill, annual sunflower, and bottlebrush squirreltail are more common.

5.5.1.2. Native species around the disturbed SWMU site on the slopes and flats include sand dropseed, red three-awn, Indian ricegrass, and a patchy distribution of needle-and-thread grass. Basin big sagebrush and black greasewood occur in the flats, and big sagebrush with antelope bitterbrush are established on the upper slopes. The mapped range and soil type is:

Range Site: Semi-Desert Gravelly Loam
Soil Types: Hiko Peak Gravelly Loam and Birdow Loam

5.5.1.3. Expected Climax Vegetation. The range site describes the climax vegetation expected to occur at each site due to the combined influence of environmental factors that are characteristic for the site. SWMU 1 occurs in the semi-desert gravelly loam range. The expected characteristic vegetation is big sagebrush, Douglas rabbitbrush, Indian ricegrass, bluebunch wheatgrass, bottlebrush squirreltail and Hood phlox (USSCS 1991).

5.5.1.4. Wildlife. No reptiles were observed at SWMU 1, but based on sightings elsewhere at the Depot, the collared and side-blotched lizard, the western whiptail, and the Great Basin rattlesnake and gopher snake may be potential inhabitants at or near SWMU 1.

5.5.1.5. Although no small mammals were observed at SWMU 1, rabbit pellets from black-tailed jackrabbits and cottontail rabbits, and valley pocket gopher mounds were observed. Based on observations elsewhere at the Depot and the type of habitat, other common small mammals that are probable inhabitants at SWMU 1 include Ord's kangaroo rat, the deer mouse, the Great Basin pocket mouse, the pinyon mouse, the sagebrush vole, the desert woodrat, and the little pocket mouse (Burt and Grossenheider, 1980; RUST, 1994).

5.5.1.6. There is no evidence from the field surveys that large mammals are present at SWMU 1. However, large mammals such as the coyote (personal communication, Dr. J. Merino), pronghorn antelope, and mule deer may occur at SWMU 1 on an intermittent basis.

5.5.1.7. Raptors such as the golden eagle, American kestrel, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, red-tailed hawk, and the great-horned owl have been observed in other areas of TEAD-N but not at SWMU 1. Because of the typical range of these species during foraging/hunting activities, raptors may be at SWMU 1 on an intermittent basis.

5.5.1.8. No passerine or other birds were observed during the field surveys. The sage grouse, a State of Utah sensitive species, may potentially inhabit the undisturbed areas of

the SWMU. Many other potential non-game birds such as crows and several families of passerine birds would not be unexpected.

5.5.1.9. Results of the Tier 1 Ecological Assessment. The field surveys indicate that the vegetation at SWMU 1 has been impacted to a greater degree by the physical activities at the site, i.e., detonation and burn activities, than by the contaminants that may have been released at the site. The ecological assessment, therefore, addresses the potential adverse impact to the wildlife receptors and it is not deemed necessary to address the effects on the vegetation. The ecological assessment was performed with the assumption that the wildlife receptors are not limited by the geographical boundaries of each SWMU. Therefore, the spatial distribution of the detected chemicals at SWMU 1 is assumed to potentially expose the wildlife species that occur or that may potentially occur at the TEAD-N facility. The results of the Tier 1 assessment indicate that the detected levels of some of the chemicals at SWMU 1 warrant a Tier 2 evaluation for SWMU 1.

5.5.2. Tier 2

5.5.2.1. The objective of the Tier 2 assessment is to further evaluate the Tier 1 COPECS by comparing the receptor's chemical exposure dose to a biological endpoint.

5.5.2.2. Exposure Analysis. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil. Indirect exposure occurs via the food web, such as when a raptor consumes the mouse. SWMU 1 has no surface water. Therefore, the surface water exposure pathway is incomplete and is excluded from the ecological assessment.

5.5.2.3. The reptiles potentially inhabiting SWMU 1 may be exposed via direct pathways (ingestion and dermal exposure to soil) and, to a lesser extent, via food web pathways (e.g. ingestion of contaminated insects). As prey, they may also expose predators.

5.5.2.4. The small mammals are predominantly exposed via direct pathways (ingestion of soil) and to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators.

5.5.2.5. The antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing) and as prey, may expose predators. The

coyote (predator) is exposed predominantly via food web pathways unless their den is located in contaminated soil which may cause a significant exposure by ingestion of soil.

5.5.2.6. The predominant route of exposure for the raptors is via food web pathways because they typically do not spend much time on the ground. The non-raptor birds are exposed via food web pathways by ingestion of seeds, grasses, and by direct exposure to soil during preening.

5.5.2.7. Risk Characterization. The ecological risk characterization for the COPECs at SWMU 1 is based on the ecological toxicity quotient derived by comparing either the dose ingested by the indicator species or the chemical concentration in the soil, to a biological endpoint. The ingestion pathway is associated with the greatest exposure at TEAD-N. The results of the ecological evaluation are in Appendix K. The results indicate that antimony, cadmium, lead, manganese, and thallium are the inorganic analytes that have ETQs greater than 1.0. The explosives, 1,3-dinitrobenzene and 2,4,6-trinitrobenzene are the organic compounds at SWMU that have ETQs greater than 1.0. These estimated ETQs, however, are likely overestimations due to the uncertainties in the evaluation. The calculations were done with the assumption that the foraging area of the receptors is exclusively within the contaminated area at SWMU 1. This conservative assumption leads to a contaminant intake or dose that is significantly higher than what is actually being ingested by the receptors.

5.5.2.8. When the foraging area exceeds the contaminated area, a correction factor that accounts for less than full-time exposure is required (deSesso, 1994). The mobility factor is a suggested method for estimating the fraction of time that a receptor may be exposed to a contaminant. The mobility factor is the ratio of the contaminated area to the foraging area and accounts for the effect of receptor mobility to the frequency and duration of exposure to the contaminated media. The areal extent of SWMU 1, however, is large enough that the mobility factor may cause only a slight reduction in the ETQs.

5.5.2.9. A factor that would contribute to the reduction in the actual ecological risk is the low bioaccumulative potential of the metals and explosives, so that the potential for impacts to higher predator trophic levels is unlikely. However, a review of the overall weight of evidence on the potential risk to the site indicates that further evaluation of SWMU 1 may be required.

5.5.2.10. Uncertainties. The evaluation does not take into account the frequency of exposure to the contaminant nor the effect of receptor mobility on the frequency and duration of contact with the contaminated media. The use of NOAEL-type values as surrogates for effective concentration has a significantly more conservative meaning as an indicator of risk. The use of NOAEL-type values assumes 100 percent bioavailability of contaminants. For soil, 100 percent bioavailability is likely an overestimate for most contaminants.

5.5.3. Recommendations

5.5.3.1. Based on the preceding discussions, it is recommended that the potential for ecological risks be further evaluated within the context of a depot-wide risk assessment. This assessment should provide an analysis on the potential for population-scale ecological risks to be present, and indicate whether any mitigating actions are necessary.

5.6 DETERMINATION OF EXPLOSIVE RISK

5.6.1. Potentially Explosive Munitions Items

5.6.1.1. During the period of May 27 - July 2, 1992, the UXO subcontractor found the following ordnance types and uncased explosives in or near the Main Demolition Area at TEAD-N:

- 20mm projectile (76 each)
- 40mm projectile (8 each)
- 90mm projectile (3 each)
- 155mm projectile
- M42 grenade (2 each)
- BLU 3 fuze (35 each)
- 2.75-inch rocket warhead
- TNT supplemental charge
- Fuze, miscellaneous (35 each)
- 4-lb incendiary bomb
- 25-lb frag bomb
- unknown ordnance item (2)
- 10.88 lbs explosive

5.6.2. Risk Interpretation

5.6.2.1. If the site continues in its present use as a demolition site, it will be restricted to properly trained personnel who are familiar with the appropriate safety precautions and are trained to recognize ordnance and explosives.

5.6.2.2. Should this site be designated as lease grazing land or have the potential for cattle to stray into the area, the hazards listed above could endanger ranchers tending the cattle or rounding up stray cattle. If the ranchers were on foot (outside of a vehicle or off horseback) in the main demolition area they would be in greater danger due to closer proximity to the hazardous items and the lack of barrier protection offered by a vehicle or horse.

5.6.3. Recommendations

5.6.3.1. Based on the preceding discussions, the following recommendations are made:

- Continue to restrict access to the Main Demolition Area to ordnance personnel employed by TEAD-N
- Prohibit building construction within this SWMU
- Provide UXO clearance of any work or sampling sites prior to performing environmental field activities in the Main Demolition Area
- Prior to releasing the land for grazing, perform ordnance clearance on 100 percent of the area to a depth of 12 inches.

6.0 BURN PAD (SWMU 1b)

6.1 SITE BACKGROUND

6.1.0.1. Site Description. The Burn Pad (SWMU 1b) is located at the OB/OD Area, in the southwestern corner of the TEAD-N facility. Figure 6-1 shows the location of the Burn Pad with respect to the larger OB/OD Area. It previously consisted of a cleared pad approximately 300 feet by 100 feet in size where propellant was burned in open trenches and projectiles were flashed. The Burn Pad is located in a small erosional valley about 2,000 feet east of the larger Main Demolition Area. No permanent structures were associated with the operations here. The area has since been regraded and revegetated, and the Burn Pad is no longer used for any demilitarization activities.

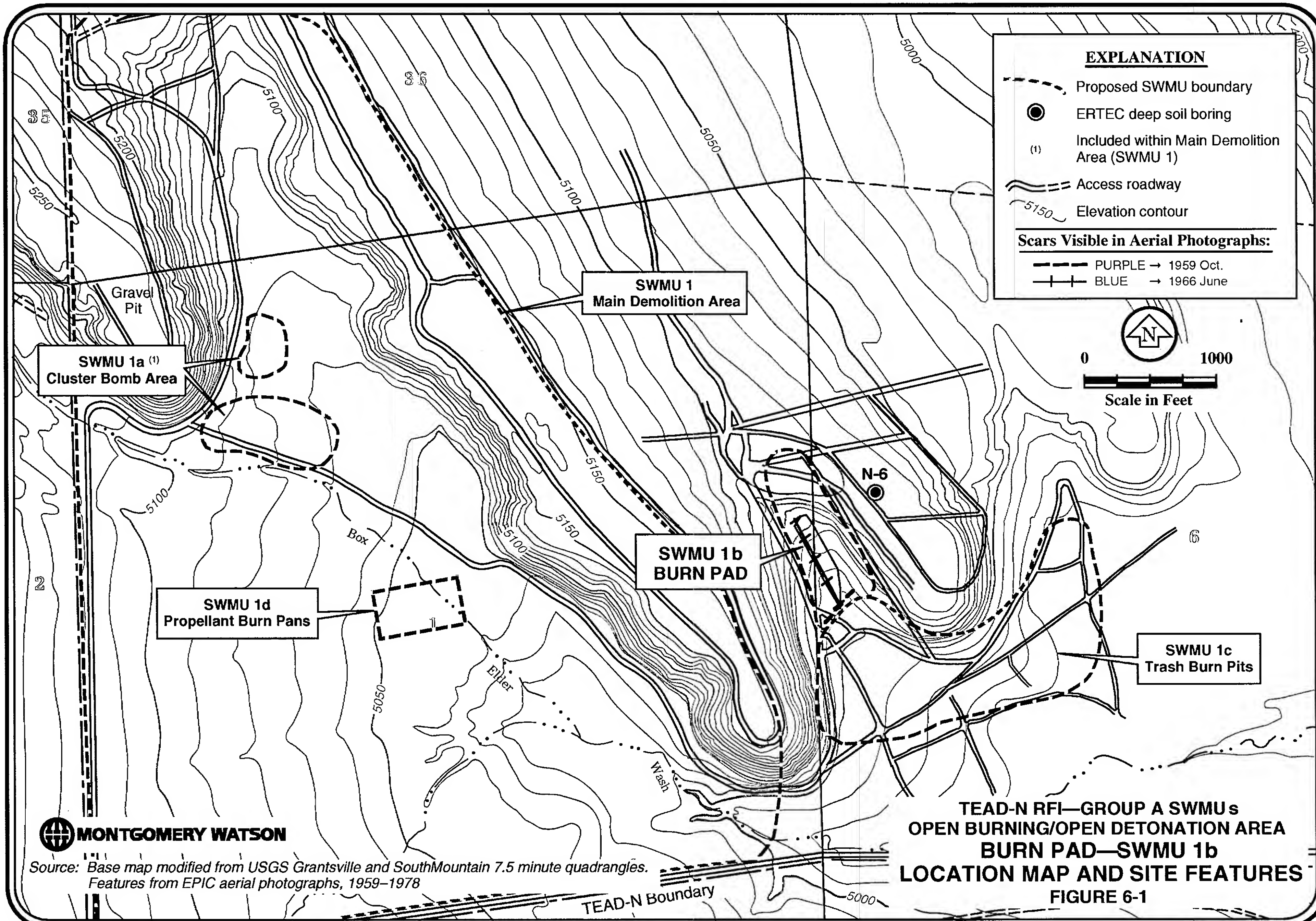
6.1.0.2. Operational Activities. Operations at the Burn Pad began prior to 1959, and open burning was reportedly discontinued before 1977 (AEHA, 1983). Analyses of aerial photographs from 1959, 1966, and 1978 revealed that five separate trenches were excavated in the pad.

6.1.0.3. Geology and Hydrology. As at the Main Demolition Area, soils underlying the Burn Pad area have been mapped by the U.S. Soil Conservation Service as Hiko Peak Series and are composed of gravelly loams developed in alluvium from mixed rock types. Depth to bedrock in this area is generally greater than 700 feet. The depth to the regional groundwater table is over 700 feet also, based on a soil boring located immediately east of SWMU 1b. This boring was drilled to 709 feet bgs without encountering the water table (ERTEC, 1982). The soil types encountered in this boring are presented in the discussion of the Main Demolition Area (SWMU 1) in Section 5.0.

6.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

6.2.1. Previous Investigations

6.2.1.1. AEHA collected and analyzed 14 surface and near-surface soil samples from the Burn Pad and its vicinity during a 1981 Phase II study (AEHA, 1982). The samples were analyzed for six explosive compounds and for EP Toxicity of the eight RCRA metals and several explosive compounds. Results of these analyses showed concentrations of arsenic, mercury, HMX, and RDX in the EP Toxicity leachate, but at levels below



Source: Base map modified from USGS Grantsville and SouthMountain 7.5 minute quadrangles.
Features from EPIC aerial photographs, 1959–1978

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
BURN PAD—SWMU 1b
LOCATION MAP AND SITE FEATURES
FIGURE 6-1

regulatory limits (USEPA, 1989) or AEHA criteria. Detections of the explosive compounds 2,4,6-TNT, 2,4-DNT, and/or 2,6-DNT were seen in two of the samples, ranging from 1.2 mg/kg to 52 mg/kg. These previous sample locations were not recorded in available documents.

6.2.2. RFI Sampling Summary

6.2.2.1. Phase I Sampling. Six test pits were excavated, sampled, and logged at the Burn Pad during the Phase I RFI in August 1992. Each test pit was sited where aerial photographs indicated that a propellant burn trench previously existed. Two soil samples were collected from each test pit for a total of 12 samples. Two soil samples from this SWMU were submitted for explosive reactivity testing by the Gap Test and the Internal Ignition Test (USBM, 1988). In addition, one 100-foot soil boring was drilled, and seven soil samples were collected from various depths in the boring. All samples were analyzed for total metals, cyanide, explosive compounds, and anions. Two of these samples were also submitted for VOC and SVOC analysis, and one soil sample (collected from a subsurface burn layer in one of the test pits) was additionally analyzed for dioxins/furans.

6.2.2.2. Phase II Activities. Data generated during the Phase I sampling at SWMU 1b were considered of sufficient quantity and quality to support a risk assessment. Therefore, no further sampling activities were conducted during the Phase II field program. An ecological survey was conducted, however, to provide further information to help identify and quantify potential risks to the environment at this SWMU.

6.2.2.3. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that all of the SWMU 1b data are usable without qualification. Because no data for this SWMU were rejected, 100 percent completeness was achieved. Further details concerning the data review are presented in Appendix E of this document.

6.2.2.4. The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviations and the data quality objectives were met. Due to this, no data gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

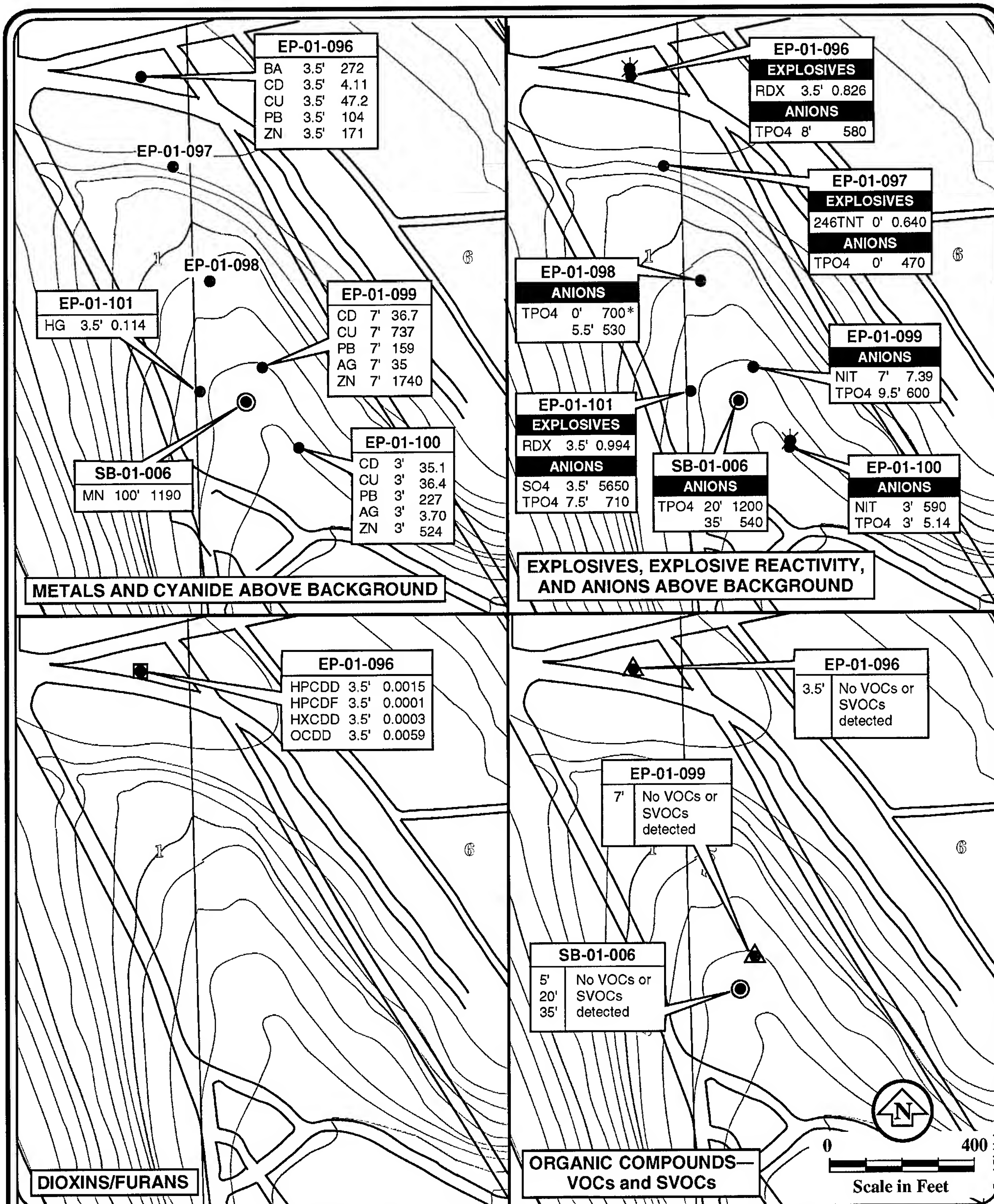
6.3 CONTAMINATION ASSESSMENT

6.3.1. RFI Sampling Results

6.3.1.1. Surface Soils. Two soil samples from SWMU 1b were collected at the surface—one from EP-01-097 and one from EP-01-098. No metals or anions above background thresholds were detected in either of these samples. The surface sample from EP-01-097 showed a concentration of 0.64 mg/kg of 2,4,6-TNT, which is very low when compared to an available risk-based soil guidance threshold of 39 mg/kg TNT in a residential soils scenario (USEPA, 1994a). Neither of these samples were submitted for VOC, SVOC, or PCDD/PCDF analysis. Figure 6-2 presents the sample locations and results for both surface and subsurface soils at SWMU 1b.

6.3.1.2. Subsurface Soils. Elevated metals in subsurface soils were found in four of the six test pits, but none were present at levels of concern based on available risk-based soil guidance thresholds (USEPA, 1994a). Test pits EP-01-099 and EP-01-100 showed the highest levels of metals, with cadmium, copper, zinc, silver, and lead present at elevated (above background) levels in each pit. Test pit EP-01-096 also contained elevated levels of barium, cadmium, lead, and zinc, but in lower concentrations. The deep soil boring showed concentrations of nickel and manganese near the bottom of the boring above the applicable background thresholds for soils. The detected level of manganese at 100 feet bgs in this boring exceeded the available risk-based soil guidance threshold for a residential soil (USEPA, 1994a).

6.3.1.3. One sample (from EP-01-096 at 3.5 feet bgs) was collected from an area of burned debris and submitted for dioxin/furan analysis. Several isomers of dioxins and furans were detected (all less than 0.01 mg/kg), but none of these were the tetrachlorinated isomer (TCDD or TCDF), which is the most toxic (Figure 6-2). However, one dioxin isomer (HXCDD) was detected here at 0.0003 mg/kg, which exceeds the available risk-based soil guidance threshold for this isomer (0.00019 mg/kg) for a residential soil (USEPA, 1994a). All samples were analyzed for the major anions; some slightly elevated levels of nitrates/nitrites and total phosphates were found. It is not known if these analytes are naturally occurring soil constituents or the by-products of explosive compounds from the previous demilitarization activities conducted at SWMU 1b.



Source: Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.

Note: All results in mg/kg.

EXPLANATION

- Test pit location
- Explosive reactivity sample location
- Deep soil boring location
- Test pit sampled for VOCs/SVOCs
- Test pit sampled for Dioxin/Furans
- Access roadway
- 5050 Elevation contour line
- * Data considered estimated. Refer to Appendix E.

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TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
BURN PAD—SWMU 1b
ANALYTICAL RESULTS FOR SURFACE AND SUBSURFACE SOILS
FIGURE 6-2

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6.3.1.4. Samples of subsurface soils from two test pits contained the explosive RDX. As shown in Figure 6-2, concentrations of this explosive were both less than 1 mg/kg. Results of the two soil samples submitted for explosive reactivity testing were both negative for shock and thermal sensitivity.

6.3.1.5. Two samples (from test pits EP-01-099 and EP-01-096) were submitted for VOC and SVOC analysis based on field screening with a photoionization detector (PID). A low concentration of tetrachloroethene was reported in the sample from EP-01-099; however, this compound was detected as a tentatively identified compound (TIC) by the SVOC method and not confirmed by the VOC method, and will not be considered in this assessment. A minor amount (less than 1 mg/kg) of a phthalate compound (B2EHP) was also detected in the 35-foot bgs sample from the deep soil boring, but it also will be disregarded as it is a common laboratory contaminant (see Section 3.2.4.4.).

6.3.2. Nature and Extent of Contamination

6.3.2.1. Evidence of burning and burial of debris was seen in four of the six test pits excavated at the Burn Pad. Sampling results have shown that contaminants have been released intermittently to the shallow subsurface soils. Elevated concentrations of several metals, including cadmium and lead, were found in five of the ten subsurface soil samples that were collected. These samples were collected in areas of ash and debris noted in the test pits. The detection of dioxins and furans in EP-01-096 was also from a sample collected from ash debris, and represents a worst-case scenario. These PCDD/PCDF compounds are probably results of the burning of pentachlorophenol-treated packing crates. The VOC/SVOC, anions, and explosives results do not show evidence of widespread surface or subsurface contamination.

6.3.2.2. The full horizontal and vertical extent of contamination has not been completely defined at this time. The degree of contamination is low when compared to the available soil guidance thresholds used for comparison purposes in this report (USEPA, 1994a), and appears to be limited to the actual zones of burning and burial of debris in shallow trenches. No evidence of surface contamination by metals or explosives is present.

6.3.3. Selection of COPCs and COPECs

6.3.3.1. Identification of COPCs. The selection of the COPCs for the Burn Pad (SWMU 1b) was generally based on the screening procedures outlined in Section 3.2.6.

However, the exposure pathways evaluated at this SWMU consist only of contact with surface soil; therefore, only surface soil data were used in the COPC selection process. A summary of all chemicals detected in soil samples from SWMU 1b, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationale for the analytes not selected as COPCs are shown in Table 6-1.

6.3.3.2. COPCs selected for the human health risk assessment at SWMU 1b include cadmium, lead, silver, and zinc, the explosive compounds 2,4,6-TNT and RDX, and dioxins/furans. The selection of COPCs was in accordance with the methodology in Section 3.2.6.

6.3.3.3. Identification of COPECs. The COPECs that are evaluated in Tier 2 and the reason for the exclusion of analytes from further evaluation are presented in Table 6-1. The only COPEC selected is the explosive compound 2,4,6-TNT.

6.3.4. Contaminant Fate and Transport

6.3.4.1. As discussed in Section 6.3.3., the contaminants of concern at SWMU 1b include metals, explosives, and dioxin/furans (Table 6-1). Table 3-4 briefly describes the fate and transport characteristics for the contaminants of concern identified in Table 6-1. The remainder of this section will present a conceptual model of contaminant fate and transport at SWMU 1b and discuss the fate and transport of the contaminants of concern .

6.3.4.2. Conceptual Model. A conceptual site model of contaminant transport has been developed (Figure 6-3) based on the physical site characteristics presented in Section 2.0 and the contamination assessment presented above. This model displays the potential routes of migration of contaminants from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear to be unlikely based on currently available data. Low levels of contamination have been released to the soils at SWMU 1b from open burning and burial of propellant and projectiles in trenches. The surface and shallow subsurface soils at SWMU 1b consist of sand, silty sand, and clay; groundwater is greater than 700 feet bgs. Surface runoff is toward the south-southeast to Box Elder Wash.

TABLE 6-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN
FOR ANALYTES DETECTED IN SOIL AT SWMU 1b–BURN PAD

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluate in Risk Assessment? Human	Evaluate in Risk Assessment? Ecological
Aluminum	1.48E+04	100	No(a)	No(a)
Arsenic	8.57E+00	100	No(a)	No(a)
Barium	2.46E+02	100	No(a)	No(a)
Cadmium	**3.67E+01**	**23**	**Yes(g)**	No(a)
Chromium	1.39E+01	100	No(a)	No(a)
Copper	7.37E+02	100	No(a)	No(a)
Lead	**2.27E+02**	**100**	**Yes**	No(a)
Manganese	3.17E+02	100	No(a)	No(a)
Mercury	1.14E-01	8	No(c)	No(a)
Nickel	2.20E+01	100	No(a)	No(a)
Silver	**3.50E+01**	**15**	**Yes(g)**	No(a)
Vanadium	1.52E+01	100	No(a)	No(a)
Zinc	**1.74E+00**	**100**	**Yes**	No(a)
Cyclonite (RDX)	**9.94E-01**	**15**	**Yes(g)**	No(f)
2,4,6-Trinitrotoluene	**6.40E-01**	**8**	**Yes**	**Yes**
Dioxins/Furans	**1.45E-05(e)**	**100**	**Yes**	No(f)

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium

Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

ND Not detected

(a) Analyte was detected at or below background concentrations in surface soil
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte contributed less than 1 percent in a concentration - toxicity screen
(d) Low toxicity metal with inadequate toxicity data
(e) Concentration based on toxicity equivalence factors
(f) Maximum concentration less than NOAEL or estimate of NOAEL
(g) Evaluate for scenarios involving subsurface soil only; not detected in surface soil.

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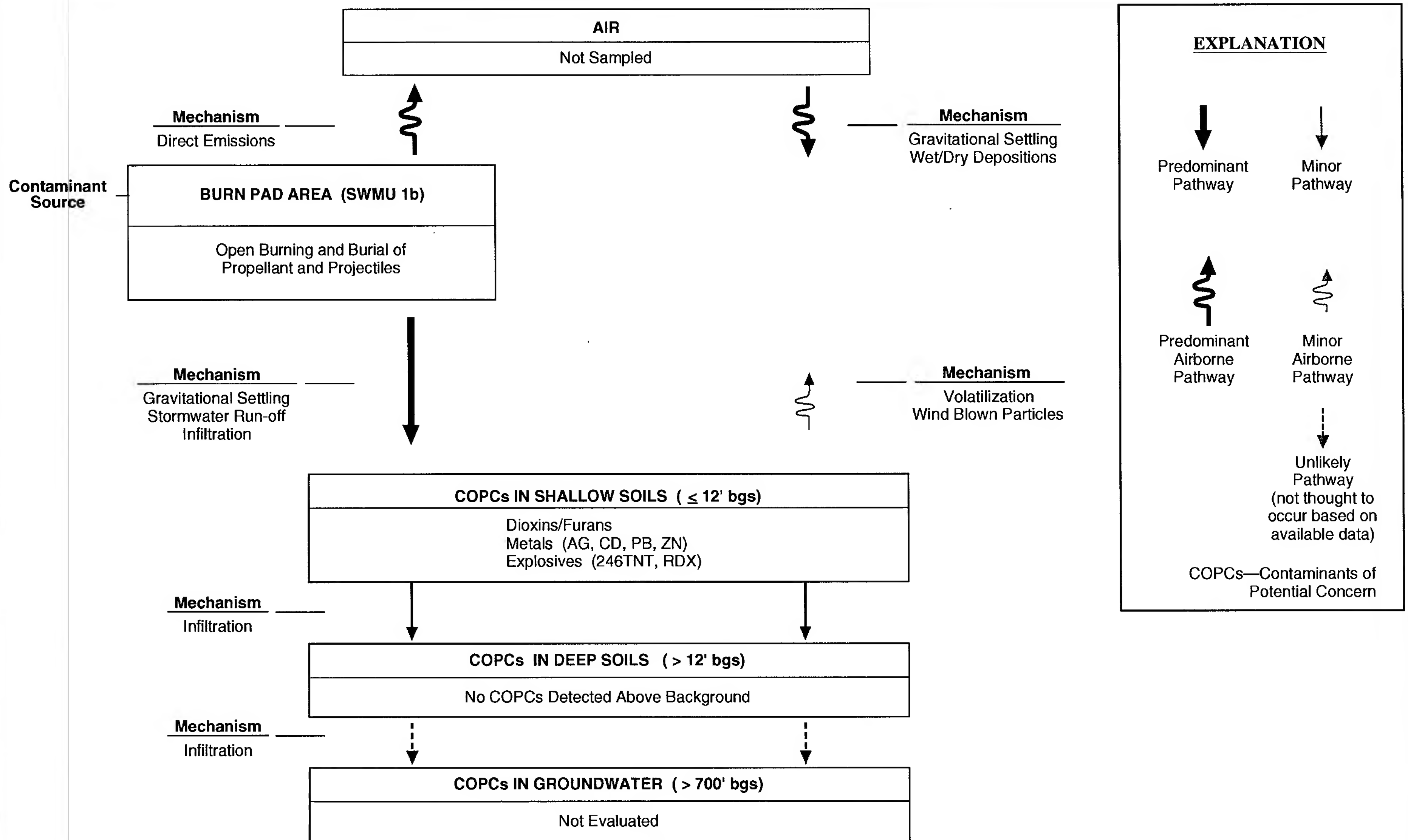

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TEAD-N RFI—GROUP A SWMUs
BURN PAD AREA—SWMU 1b
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 6-3

6.3.4.3. Fate and Transport of Metals. Transport of metals from the surface and shallow soils through the deeper soil horizons to groundwater is not expected based on relatively low metals concentrations in the soil, the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow soils, neutral to slightly basic pH soils, and because groundwater is more than 700 feet below the ground surface. The deep soil boring (SB-01-006) drilled to 100 feet bgs at SWMU 1b indicated that few elevated metals concentrations are present below 10 feet bgs. Metals detected above background at depths greater than 10 feet bgs consist of manganese and nickel, which were detected only slightly above their background thresholds and may represent the natural abundance of these metals at depth. Potential for off-site migration of metal contaminants via a surface-water pathway appears to be minimal since soil samples collected down gradient of the Burn Pad (at Box Elder Wash) indicated that no elevated metals contamination was present. Any metal contaminants present at the surface could provide particulates to the air pathway; however, no elevated metals were detected in either of the surface soil samples collected.

6.3.4.4. Fate and Transport of Explosives. Explosives were detected in very low concentrations at SWMU 1b (< 1 mg/kg). Even though explosive compounds tend to be mobile in the environment, the potential for leaching of explosives to the deep soils (> 10 feet bgs) or groundwater is unlikely because of the low concentrations at the surface and in the shallow subsurface. At SWMU 1b, attenuation of explosive concentrations in the surface soils would be expected through slow volatilization to the atmosphere or by slow photolytic transformations. In the subsurface soil, attenuation by slow biodegradation would be anticipated.

6.3.4.5. Fate and Transport of Dioxins and Furans. Only one of the test pits sampled at SWMU 1b was analyzed for dioxin/furans. Four dioxin/furan compounds were detected at SWMU 1b in sample EP-01-096 in the shallow subsurface (3.5 feet bgs); they are expected to strongly absorb to the soil and be relatively immobile. There is little potential for these compounds to leach under normal environmental conditions. Surface water runoff will have only very local transport effects because these contaminants tend to strongly adsorb to soil and sediments, and because precipitation rates are low. The surface contaminants may also provide particulates to the air pathway.

6.4 HUMAN HEALTH RISK ASSESSMENT

6.4.0.1. The methods used to estimate the risks associated with SWMU 1b are given in the Human Health Risk Assessment Methodology, discussed in Section 3.2.6. The COPCs were identified in the preceding section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 1b) follows.

6.4.1. Exposure Pathways and Receptors

6.4.1.1. The pathways quantitatively evaluated in the BRA are: (1) those that are complete or are likely to be completed in the future, and (2) those that may potentially cause a significant risk. An evaluation of completeness is shown on Figure 6-4, which is a diagram of exposure pathways for SWMU 1b. An evaluation of pathway completeness and an assessment of whether the pathway is significant enough to require further evaluation for current and potential future receptors at SWMU 1b is given in Tables 6-2 and 6-3, respectively.

6.4.1.2. Current receptors at SWMU 1b include security personnel and others who periodically monitor or patrol the area. Potential future on-Depot receptors for contaminants originating at SWMU 1b include construction workers. As shown in the exposure pathway diagram (Figure 6-4), construction workers can be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For future construction workers, direct exposure results from the anticipated excavation activities associated with construction, and includes subsurface soil as well as surface soil. Because of the remoteness of this SWMU, the presence of unexploded ordnance, the large areas of undeveloped land on the Depot, and the presence of adequate OB/OD facilities, future development of this area by the Depot is not foreseen. Although future scenarios involving construction workers are unlikely, this scenario has been evaluated to provide a benchmark for contaminants in near-surface soil.

6.4.1.3. Should this portion of the Depot be closed in the future (it is not slated for closure at this time), future residents could also become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. However, their contact would be confined to contaminants in surface soil. It should be noted that a residential development is unlikely. Even if the Depot is closed, the remote

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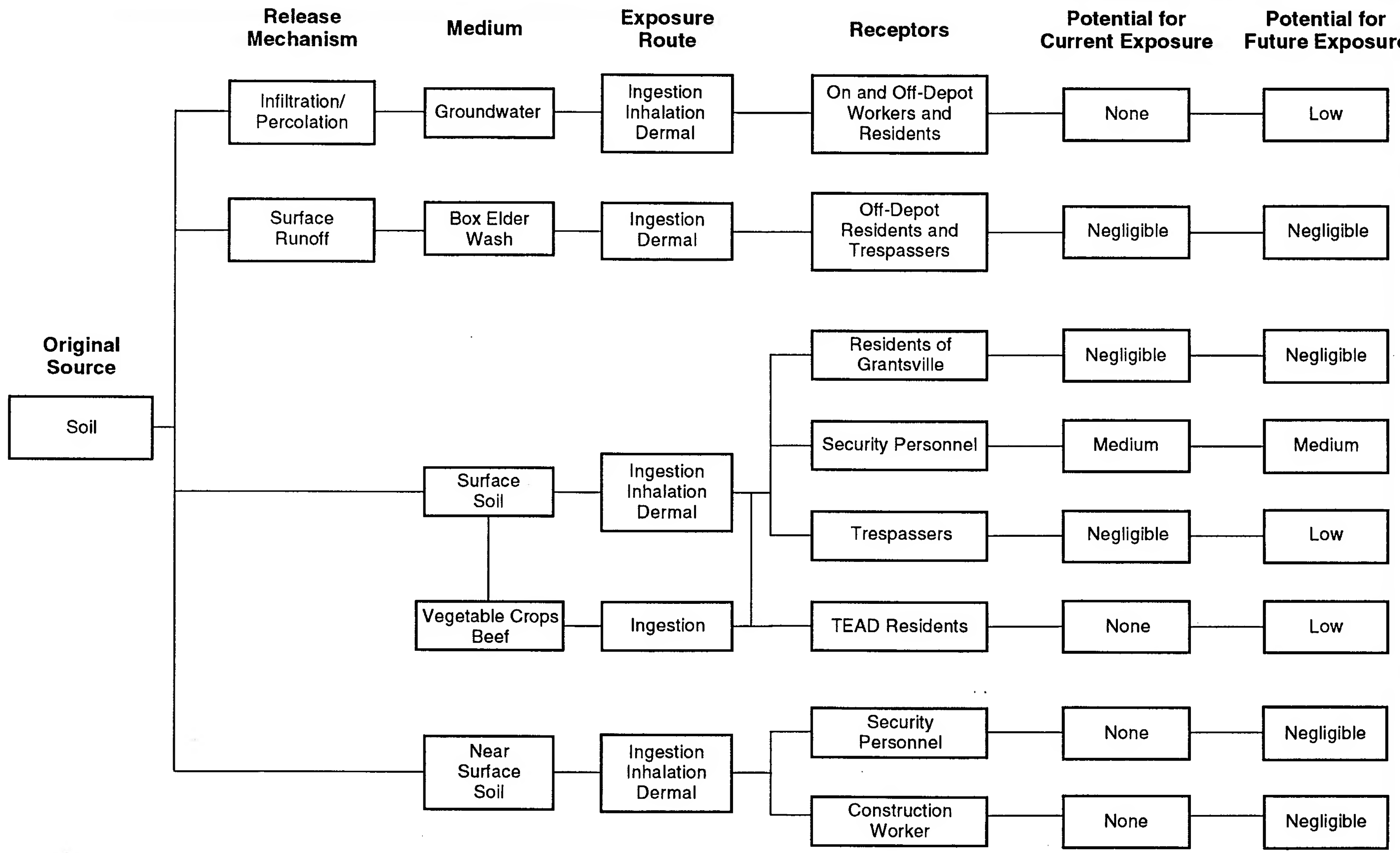

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TEAD-N RFI—GROUP A SWMUs
BURN PAD—SWMU 1b
EXPOSURE PATHWAYS DIAGRAM
FIGURE 6-4

TABLE 6-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 1b: BURN PAD

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is about 700 feet below ground surface. Soil samples from 10 feet to the maximum depth explored of 100 feet below ground surface were not contaminated.
Surface Water and Sediment			
Box Elder Wash	Trespasser and off-Depot residents	Incidental ingestion and dermal contact with water or sediment	No. Only rarely is there water in the wash. Samples collected from the wash were not contaminated.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. Emissions are anticipated to be small because SWMU 1b is much smaller and has a much lower level of contamination than SWMU 1 where this pathway showed no potential for significant risk.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. No evidence of trespassers, i.e. no tracks or sightings.
	Depot Security Personnel	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Security personnel periodically inspect this area.
Air	Depot Security Personnel	Inhalation of volatile organics from subsurface soil	No. Volatile organics were not detected. Dust exposure evaluated under soil.

TABLE 6-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 1b : BURN PAD

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely to result in the future. Groundwater is over 700 feet below the below ground surface and evapotranspiration is high.
Surface Water and Sediment			
Box Elder Wash	Trespassers and future residents	Incidental ingestion, dermal contact with water or sediment	No. Only rarely is there water in the wash. Samples collected from the wash were not contaminated and this SWMU is no longer active.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. Emissions are anticipated to be small because SWMU 1b is much smaller and has a much lower level of contamination than SWMU 1 where this pathway showed no potential for significant risk.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Although a future residential scenario is unlikely because the Depot does not anticipate closing this area; this pathway will be evaluated.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Future trespassers will have less exposure than a resident.
	Depot security personnel	Incidental ingestion of dust, inhalation, and dermal contact	No. Exposure will be the same as that evaluated under current conditions.
Near-surface Soil	Construction worker	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Although future scenarios involving construction workers are unlikely, this scenario has been evaluated to provide a risk benchmark for contaminants in near surface soil. This SWMU is in a remote area of the Depot where there are no buildings and where unexploded ordnance is present. The Depot has large areas of undeveloped land and can build outside of this SWMU more cheaply. All OB/OD activities can be conducted within permitted areas. Use of SWMU 1b for OB/OD activities would require a RCRA part B permit.
Air	Depot personnel	Inhalation of volatile organics from subsurface soil	No. Volatiles organics were not detected. Dust exposure evaluated under soil.

TEAD-N Tooele Army Depot North Area

nature of SWMU 1b would tend to preclude residential development. However, because of the requirements of UAC 315-101 (1994), a residential scenario was evaluated.

6.4.1.4. SWMU 1b could be converted into an area where crops are grown. However, efforts to grow vegetables in soil from adjacent areas failed (Rust E&I, 1995). The experiments included soil from an area where there was no known release of hazardous chemicals. It was concluded that the salt content of the soil was "toxic", and that vegetables could not be grown without leaching salt from the soil. Although such activities are considered unlikely, this pathway is evaluated as part of the future residential scenario.

6.4.1.5. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. This pathway is also evaluated as part of the future residential scenario.

6.4.1.6. For the pathways that were evaluated quantitatively (see Tables 6-2 and 6-3), site specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are given in Appendix K.

6.4.2. Risk Characterization

6.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 1b. The methods for calculating the risks are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

6.4.2.2. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable (unless there are reasons to believe the risks have been underestimated), a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these two values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects are possible.

6.4.2.3. In addition to the calculated, quantitative estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include deciding whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk estimates. When decisions are made regarding whether or not COPCs pose an unacceptable risk, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for security personnel and potential future residents.

6.4.2.4. Depot Security Personnel. Security personnel were assumed to be potentially exposed to COPCs in the near-surface soil. The security personnel were assumed to visit the site once per week for one hour per visit. The personnel activities were assumed to consist mainly of patrolling the SWMU in a vehicle. The estimates of risk for security personnel are presented in Table 6-4.

6.4.2.5. For SWMU 1b, the calculated excess lifetime cancer risk for security personnel is 2 x 10^{-7}, which is below the benchmark of 1 x 10^{-6}. The cancer risk is dominated by dermal exposure to dioxins/furans. Dioxins/furans are considered probable human carcinogens by EPA. The pathway is thought to have a low to moderate potential to be completed depending on the need to leave the vehicle while patrolling the area. A summary of the risk estimates and qualitative factors affecting these estimates is presented in Table 6-5.

6.4.2.6. The total hazard index for security personnel was estimated to be 0.0004, indicating that adverse health effects are not expected (Table 6-4). While the inhalation exposure pathway has not been accounted for due to the absence of inhalation reference doses for the COPCs, the exposure doses are in a range where adverse health effects are unlikely (see Appendix K for the exposure doses). Lead was not evaluated because it was below the background threshold for that element in surface soil.

6.4.2.7. Potential Construction Worker. Potential future construction workers are assumed to be exposed to COPCs in the soil from a depth of 0 to 12 feet during excavation activities. The estimated excess lifetime cancer risk was 2 x 10^{-7} (Table 6-6), which is below the benchmark of 1 x 10^{-6}. Most of the cancer risk is from the inhalation of cadmium, and ingestion and dermal exposure to dioxins/furans.

TABLE 6-4

SWMU 1b - BURN PAD
RME CANCER RISK AND HAZARD INDEX
FOR SECURITY PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
2,4,6-Trinitrotoluene	6.40E-01	1E-10	2E-09	NC	2E-09	<1
Dioxins/Furans	1.45E-05	2E-08	2E-07	2E-10	2E-07	99
Pathway Total		2E-08	2E-07	2E-10		
Percent of Total		6	94	<1		
			Total Cancer Risk:		**2E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Lead	1.70E+01	NC	NC	NC	NC	NC
Zinc	6.18E+01	4E-06	6E-06	NC	1E-05	2
2,4,6-Trinitrotoluene	6.40E-01	3E-05	4E-04	NC	4E-04	98
Pathway Total		3E-05	4E-04	NC		
Percent of Total		7	93	NC		
			Total Hazard Index:		**4E-04**	
	Blood Lead Concentration µg/dl (95th percentile):				**3.4**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 6-5

TEAD-N BASELINE RISK ASSESSMENT
SWMU 1b – BURN PAD PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (μg/dl)	Key Chemicals[a]
Depot Personnel						
Ingestion	Current moderate	Medium/High	0.00003	2×10^{-8}	3.4	Dioxins/furans, 2,4,6-Trinitrotoluene
Dermal	Current moderate	Medium/High	0.0004	2×10^{-7}		
Inhalation	Current moderate	High/High	NC	2×10^{-10}		
TEAD-N Resident						
Ingestion	Future unlikely	Medium/High	0.02	3×10^{-6}	6.3	2,4,6-Trinitrotoluene, dioxins/furans
Dermal	Future unlikely	High/High	0.004	2×10^{-6}		
Inhalation	Future unlikely	High/High	NC	1×10^{-8}		
Vegetable Crops	Future unlikely	High/High	70	2×10^{-4}		
Beef	Future unlikely	High/Neutral	0.000008	2×10^{-8}		
Construction Worker						
Ingestion	Future unlikely	Medium/High	0.04	8×10^{-8}	3.5	Cadmium, dioxins/furans
Dermal	Future unlikely	High/Neutral-High	0.005	2×10^{-8}		
Inhalation	Future unlikely	High/High	NC	1×10^{-7}		

TEAD-N Tooele Army Depot North Area

NC Not calculated

(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

TABLE 6-6

SWMU 1b - BURN PAD
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	1.26E+01	NC	NC	1E-07	1E-07	52
Cyclonite (RDX)	5.03E-01	2E-09	2E-09	NC	4E-09	2
2,4,6-Trinitrotoluene	3.16E-01	3E-10	1E-10	NC	4E-10	<1
Dioxins	1.45E-05	7E-08	2E-08	3E-09	1E-07	46
Pathway Total		8E-08	2E-08	1E-07		
Percent of Total		35	11	53		
			Total Cancer Risk:		**2E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Cadmium	1.26E+01	3E-02	4E-03	NC	3E-02	76
Lead	6.82E+01	NC	NC	NC	NC	NC
Silver	8.00E+00	4E-03	3E-04	NC	4E-03	9
Zinc	4.49E+02	4E-03	1E-04	NC	4E-03	8
Cyclonite (RDX)	5.03E-01	4E-04	4E-04	NC	7E-04	2
2,4,6-Trinitrotoluene	3.16E-01	1E-03	5E-04	NC	2E-03	5
Pathway Total		4E-02	5E-03	NC		
Percent of Total		88	12	NC		
			Total Hazard Index:		**4E-02**	
		Blood Lead Concentration μg/dl (95th percentile):			**3.5**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

6.4.2.8. The total hazard index for potential construction workers was estimated to equal 0.04 (Table 6-6), indicating that adverse health effects are not expected. While the inhalation exposure pathway has not been accounted for due to the absence of inhalation reference doses for the COPCs, the exposure doses are in a range where adverse health effects are unlikely (see the discussion of uncertainties in Section 6.4.3.; Appendix K summarizes the exposure doses). The concentration of lead in blood was estimated to be 3.5 µg/dl, which is in the range where no health effects are expected.

6.4.2.9. Potential Future TEAD-N Resident. Potential future residents at TEAD-N were assumed to be exposed to COPCs in the surface soil from a depth of 0 to 0.5 feet. The cancer risk from all exposure pathways was estimated to equal 2 x 10^{-4}, and the hazard index was estimated to equal 70. The excess lifetime cancer risk from potential exposure to soil was estimated to be 5 x 10^{-6} (Table 6-7). However, dioxins/furans were requested analytes in only one sample, which was collected from an ash/debris zone at a depth of 3.5 feet. The presence or absence of dioxins/furans in surface soil is unknown; the results from this one sample were used to estimate dioxin/furan concentrations in surface soil and is likely an overestimate. If this sample is representative of site-wide dioxin/furan concentrations, overestimates of the soil ingestion rate and area of dermal contact would indicate that the cancer risk is in the vicinity of 1 x 10^{-6} (see Section 6.4.3.). The significance of these risk estimates is diminished because the potential for pathway completeness is low.

6.4.2.10. The total hazard index for potential future child residents exposed to soil at SWMU 1b was estimated to equal 0.02 (Table 6-7). This result does not indicate a potential for adverse health effects. The concentration of lead in blood was estimated to be 6.3 µg/dl, which is lower than the concentration at which adverse health effects have been observed in children.

6.4.2.11. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 1b, the estimated cancer risk is 2 x 10^{-4} and the hazard index is 70 (Table 6-7), primarily due to the explosive 2,4,6-TNT. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has several orders of magnitude of uncertainty because of uncertainties in the plant uptake factors (see Section 6.4.3.). If plants metabolize explosives (which is not accounted for in the uptake model), the risks from explosives via this pathway would be low. Because of the high degree of uncertainty, the significance of these risk estimates is unknown.

TABLE 6-7

SWMU 1b - BURN PAD
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
2,4,6-Trinitrotoluene	6.40E-01	3E-08	2E-08	NC	2E-04	4E-14	2E-04	87
Dioxins/Furans	1.45E-05	3E-06	2E-06	1E-08	2E-05	2E-08	3E-05	13
Pathway Total		3E-06	2E-06	1E-08	2E-04	2E-08		
Percent of Total		1	<1	<1	98	<1		
					Total Cancer Risk:		**2E-04**	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Lead	1.70E+01	NC	NC	NC	NC	NC	NC	NC
Zinc	6.18E+01	3E-03	6E-05	NC	NC	8E-06	3E-03	<1
2,4,6-Trinitrotoluene	6.40E-01	2E-02	4E-03	NC	7E+01	2E-08	7E+01	100
Pathway Total		2E-02	4E-03	NC	7E+01	8E-06		
Percent of Total		<1	<1	NC	100	<1		
					Total Hazard Index:		**7E+01**	
			Blood Lead Concentration µg/dl (95th percentile):				**6.3**	

CR	Cancer risk
HI	Hazard index
NA	Not applicable
NC	Not calculated
RME	Reasonable maximum exposure
TEAD-N	Tooele Army Depot North Area

6.4.2.12. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 1b, the estimated cancer risk is 2 x 10^{-8} and the hazard index is 8 x 10^{-6} (Table 6-7). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 1b if they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

6.4.3. Uncertainties

6.4.3.1. The exposure estimates and toxicity values have associated uncertainties. The magnitude and nature of these uncertainties affects the confidence in the results. Most of the uncertainties are such that risk estimates could be lower, but are unlikely to be higher than estimated. The following paragraphs discuss uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor. These discussions are focused on elements contributing most to overestimates of the total risk, and on those elements where risks may be underestimates. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk.

6.4.3.2. The exposure point concentrations (concentrations of chemicals in an environmental medium at the point where a receptor is exposed) used in the risk calculations were based in part on judgmental sampling. Where observed, samples were collected from, or immediately below, stained soil or debris within trenches where munitions were burned. Because trenches occupy only a small portion of this SWMU, and because soil beneath stained areas would tend to represent the most contaminated area of the trench, the exposure point concentrations are representative of the most contaminated areas of the area, rather than for the SWMU as a whole. However, because only two surface soil samples were analyzed, this small population size results in a lower confidence in the exposure point concentrations used for the surface soil scenarios.

6.4.3.3. Another possible exception is dioxins/furans, for which only one sample was analyzed. As representative of burned material only, it is expected that the sample would be more contaminated than surface soil from the Burn Pads in general. This can be demonstrated as follows. Assume that ash that is entrained as smoke and undergoes deposition in the soil has a higher dioxin/furan content that remains in the burn pit. This could perhaps occur if ash from smoke is formed at a higher temperature than ash that remains behind (although this is not obviously the case). Higher temperatures lead to higher dioxin furan content. In one study, dioxin/furan formation at 300°C was 8 to 20 times that at 120°C (USEPA, 1993c). If all of the ash in the smoke was formed at the higher temperature and all of the ash left behind in the burn pit was formed at the lower temperature, the soil where the ash deposition occured would need to become between 5 and 12.5 percent ash (i.e., between 1/20 and 1/8) to have the same dioxin/furan concentration as the ash in the burn pits. This is highly improbable even immediately after a burn. When it is considered that the surface soil has been scoured by wind for the almost 20 years since burn operations have ceased, it is clear that the dioxin/furan content of burn pit ash is conservative relative to concentrations in surface soil.

6.4.3.4. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

6.4.3.5. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical with a reference dose below 1×10^{-6} mg/kg/day, thus this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation of metals with exposure doses greater than 1×10^{-6} was

examined on a case-by-case basis. The results of this evaluation are presented in Section 6.4.2. Exposure doses are summarized in Appendix K.

6.4.3.6. Depot Security Personnel. Because no significant risks were calculated and uncertainties tend to result in an overestimate of risks, the specific uncertainties do not require a detailed discussion. The greatest uncertainty for inhalation is the concentration of respirable dust. For dermal exposure, the uncertainties involve the area of exposed skin which hypothetically becomes covered with contaminated soil. Uncertainties related to the absorption factor are low for dioxins, as these compounds have been well studied (USEPA, 1992). The only other COPC is TNT, and it would not generate a cancer risk of one in one million even with 100-percent absorption.

6.4.3.7. Potential Construction Worker. Uncertainties associated with the exposure dose for a construction worker are high. As discussed in Section 5.0, a reasonable ingestion rate is probably a factor of 3.5 less than the 480 mg/day used in this risk assessment. Also the bioavailability of the contaminants in the soil is likely to be less than the 100 percent assumed for the BRA, further reducing the actual dose and corresponding risk. The BRA assumed a dust concentration of 1 mg/m^3, which is the upper end of the range of dust levels measured while digging test pits at SWMU 1 (although most of the time dust levels were lower).

6.4.3.8. Future TEAD-N Residents. Residential soil exposure estimates indicated only a potential for significant risk with dioxins and furans, which were detected in ash rather than soil. Consequently, the representativeness of this result is questionable. For other COPCs, the only uncertainties requiring discussion are those where risk could be underestimated. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who directly eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate exceeds the assumed rate of 200 mg/day.

6.4.3.9. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

6.4.3.10. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53.

6.4.3.11. There is even greater uncertainty at SWMU 1b. The estimated risks for the produce exposure pathway are dominated by 2,4,6-TNT. However, the equation used to estimate the plant uptake factors from the log K_{ow} was developed using mostly data for pesticides, which are very different from explosives; a poorer fit would be expected for explosives than for compounds used to develop the relationship. The plant uptake model also does not account for metabolism of the chemical by the plant. Based on their polar structure, it would not be surprising if plants metabolize 2,4,6-TNT, thus eliminating exposure to explosives by humans through this pathway. In addition, because the salt content of the soil is currently toxic to plants (see Section 6.4.1.4.), the soil would need to be diluted with peat or other soil amendments to grow produce. This has not been accounted for in the exposure calculations. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

6.4.4. Recommendations

6.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Allow unrestricted use of this site as long as it remains part of the depot

- Evaluate the need for institutional controls and/or corrective action in a Corrective Measures Study should this land no longer be controlled by the depot.

Note that the recommendation for unrestricted land use is made solely with respect to human health risks from chemical toxicity. Restrictions are recommended based on the potential for explosive risks, as discussed in Section 6.6.

6.5 ECOLOGICAL RISK ASSESSMENT

6.5.0.1. This section discusses the results of the Tier 1 and Tier 2 evaluations. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4.

6.5.1. Tier 1

6.5.1.1. Ecological Receptors. The majority of the SWMU 1b area has been disturbed and currently supports both native and weedy, introduced species. SWMU 1b has the greatest re-establishment of native species (e.g., Douglas rabbitbrush and Indian ricegrass) relative to SWMUs 1, 1c, and 1d. The weedy species in the previously disturbed areas consist of cheatgrass, Russian thistle, annual sunflower, storksbill, blobemallow and gumweed. Scattered Utah juniper and big sagebrush are also present in the area. The mapped range and soil type are:

Range Site: Semi-Desert Gravelly Loam
Soil Type: Hiko Peak Gravelly Loam with 2-15 percent slopes

6.5.1.2. Expected Climax Vegetation.. The range site describes the climax vegetation expected to occur at each site due to the combined influence of environmental factors that are characteristic for the site. The observed dominant vegetation in undisturbed areas includes big sagebrush, Douglas rabbitbrush, needle-and-thread grass, Indian ricegrass, and sand dropseed. These species are the expected dominant vegetation for this range site (USSCS, 1991).

6.5.1.3. Wildlife. No reptiles were observed at SWMU 1b. Based on sightings elsewhere at the Depot, the collared and side-blotched lizard, the western whiptail, the Great Basin rattlesnake and the gopher snake may be potential inhabitants at or near SWMU 1b.

6.5.1.4. Although no small mammals were observed at SWMU 1b, rabbit pellets from black-tailed jackrabbits and cottontail rabbits were observed, along with valley pocket gopher mounds. Based on observations elsewhere at the Depot and the type of habitat, the common small mammal species that are probable inhabitants at SWMU 1b include

the Ord's kangaroo rat, the deer mouse, Great Basin pocket mouse, pinyon mouse, sagebrush vole, the desert woodrat, and the little pocket mouse (Burt and Grossenheider, 1980; RUST E&I, 1994).

6.5.1.5. There is no evidence from the field surveys that large mammals are present at SWMU 1b. However, large mammals such as the coyote (personal communication, Dr. J. Merino), pronghorn antelope, and mule deer may be present at SWMU 1b on an intermittent basis.

6.5.1.6. Raptors such as the golden eagle, American kestrel, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, red-tailed hawk, and great-horned owl have been observed in other areas of TEAD-N but not at SWMU 1b. Because of the typical range of these species during foraging/hunting activities, raptors may be present at SWMU 1b on an intermittent basis.

6.5.1.7. No passerine or other birds were observed during the site visit. The sage grouse, a State of Utah sensitive species, may potentially inhabit the undisturbed areas of the SWMU. Many other non-game birds such as crows and several families of passerine birds would not be unexpected.

6.5.1.8. Results of the Tier 1 Ecological Assessment. The field surveys indicated that the vegetation at SWMU 1b has been impacted to a greater degree by the physical activities at the site (i.e., detonation and burn activities) than by the chemicals that have been released at the site. The ecological assessment, therefore, addresses the potential adverse impact to the wildlife receptors and it is not deemed necessary to address the ecological effects on the vegetation. The ecological assessment is performed with the assumption that the wildlife receptors are not limited by the physical boundaries of each SWMU. Therefore, the distribution of the detected chemicals at SWMU 1b is assumed to potentially expose the wildlife species that occur, or that may potentially occur, at the TEAD-N facility as a whole. The results of the Tier 1 assessment indicate that the levels of some of the chemicals detected at SWMU 1b warrant a Tier 2 evaluation.

6.5.2. Tier 2

6.5.2.1. The objective of the Tier 2 assessment is to further evaluate the Tier 1 COPECs by comparing the receptor's chemical exposure dose to a biological endpoint.

6.5.2.2. Exposure Analysis. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil. Indirect exposure occurs via the food web, such as when a raptor consumes the mouse. SWMU 1b has no surface water, so the surface water exposure pathway is incomplete and is excluded from the ecological assessment. The direct exposure pathways at SWMU 1b are soil ingestion and dermal exposure. Indirect exposure occurs through the ingestion of contaminated prey via the food web pathways.

6.5.2.3. The reptiles potentially inhabiting SWMU 1b may be exposed via direct pathways (ingestion and dermal exposure to soil) and, to a lesser extent, via food web pathways (e.g., ingestion of contaminated insects). As prey, they may also expose predators.

6.5.2.4. Small mammals are exposed predominantly via direct pathways (ingestion of soil) and, to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators.

6.5.2.5. The antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing) and, as prey, may expose predators. The coyote (a predator) is exposed predominantly via food web pathways unless their den is located in contaminated soil, which may cause a significant direct exposure by ingestion of soil.

6.5.2.6. The predominant route of exposure for the raptors is via food web pathways. The non-raptor birds are exposed via food web pathways by ingestion of seeds, grasses, and by direct exposure to soil during preening.

6.5.2.7. Risk Characterization. The COPECs at SWMU 1b are based on the ecological toxicity quotient (ETQ) derived by comparing either the dose ingested by the indicator species or the chemical concentration in the soil to a biological endpoint. The ingestion pathway is associated with the greatest exposure at TEAD-N. The results indicate that barium and 2,4,6-TNT are the COPECs at SWMU 1b that have ETQs greater than 1.0. These ETQs, however, are overestimations due to the uncertainties in the evaluation. The calculations were done assuming that the foraging area of the receptors is exclusively within the contaminated area at SWMU 1b. This conservative assumption leads to a contaminant intake or dose that is significantly higher than what is actually being ingested by the receptors. The results of the ecological evaluation are in Appendix K.

6.5.2.8. When the foraging area exceeds the contaminated area, a correction factor that accounts for less than full-time exposure is required (deSesso, 1994). Use of a mobility factor is a suggested method for estimating the fraction of time that a receptor may be exposed to a contaminant. The mobility factor is the ratio of the contaminated area to the foraging area and accounts for the effect of receptor mobility to the frequency and duration of exposure to the contaminated media. The areal extent of SWMU 1b is very small relative to the foraging area of the selected indicator species, thus significantly reducing the ETQs and the potential for adverse impacts to the ecological receptors. The receptors that may have a high exposure are the less mobile receptors such as reptiles or small mammals. The field surveys did not observe these species at SWMU 1b, but the ecological assessment identified them as potentially occurring at the site. Based on the size of the SWMU, the impact to less mobile terrestrial receptors at SWMU 1b is not significant enough to adversely affect the structure and function of the ecosystem due to the limited number of individuals potentially affected.

6.5.2.9. The metals and explosives evaluated at SWMU 1b have relatively low bioaccumulative potential, and thus the potential for impacts to higher predator trophic levels is unlikely. Based on these results, SWMU 1b is recommended for no further investigation into the potential for ecological effects.

6.5.2.10. Uncertainties. The evaluation does not take into account the frequency of exposure to the contaminant nor the effect of receptor mobility on the frequency and duration of contact with the contaminated media. The use of NOEL-type values as surrogates for effective concentration has a significantly more conservative meaning as an indicator of risk. The use of NOEL-type values assumes 100 percent bioavailability of contaminants. For soil ingestion, 100 percent bioavailability is probably an overestimate for most contaminants.

6.5.3. Recommendations

6.5.3.1. Based on the preceding discussions, SWMU 1b is recommended for no further investigation regarding potential ecological effects.

6.6. DETERMINATION OF EXPLOSIVE RISK

6.6.1. Potentially Explosive Munitions Items

6.6.1.1. During the period of August 4 to 6, 1992, the UXO subcontractor found the following ordnance types and uncased explosives in or near SWMU 1b (the Burn Pad), Tooele Army Depot North (TEAD-N).

- 6-oz explosives (1-oz to 2-oz pieces)
- Projectile fuze

6.6.2. Risk Interpretation

6.6.2.1. Because this area is currently not used, access should be restricted to properly trained personnel who are familiar with the appropriate safety precautions and are trained to recognize ordnance and explosives. Should this site be designated as lease grazing land or have the potential for cattle to stray into the area, the explosive hazards listed could endanger ranchers tending the cattle or rounding up stray cattle. If the ranchers were on foot (outside of a vehicle or off horseback) in the Burn Pad area they would be in greater danger due to closer proximity to the hazardous items and the lack of barrier protection offered by a vehicle or horse.

6.6.3. Recommendations

6.6.3.1. Based on the preceding discussions, the following recommendations are made:

- Continue to restrict access to SWMU 1b to ordnance personnel employed by TEAD-N. These personnel should conduct a surface and subsurface UXO clearance prior to building fires in this area to avoid unintentionally detonating ordnance.

- Provide UXO clearance of any work or sampling sites prior to performing environmental field activities in the Burn Pad site.

- Prior to releasing the land for grazing, perform ordnance clearance on 100% of the area to a depth of 12 inches.

7.0 TRASH BURN PITS (SWMU 1c)

7.1 SITE BACKGROUND

7.1.0.1. Site Description. The Trash Burn Pits (SWMU 1c) are located at the OB/OD Area, in the southwestern corner of the TEAD-N facility, and lie in an open area around the base of an eroded Lake Bonneville gravel bar. SWMU 1c is located in a small erosional valley about 2,000 feet east of the larger Main Demolition Area, and adjoins the Burn Pad (SWMU 1b) to the north. Figure 7-1 shows the location of the Trash Burn Pits with respect to the larger OB/OD Area. This area was previously used for the open burning of waste packaging material potentially contaminated with explosives. The area has since been regraded and revegetated, and is no longer used for any disposal activities. No permanent structures were associated with the operations here.

7.1.0.2. Operational Activities. Various types of waste have reportedly been burned and disposed of in the Trash Burn Pits. Debris from propagation testing and solvent drums were observed during a previous investigation (AEHA, 1983). Wastes contaminated with volatile organic compounds were also reportedly disposed of here. Open detonation of munitions is not believed to have occurred at this SWMU (McCoy, 1989).

7.1.0.3. Large pits were excavated using heavy equipment and filled with waste materials to be burned. When the pit was filled with ash and debris, it was covered and regraded, and a new pit was dug. Pits were up to several hundred feet long, 8-10 feet wide, and 4-6 feet deep (Rutishauser, 1990). Analysis of aerial photographs of this area shows that activities at SWMU 1c pre-date 1959. Interviews with Depot personnel familiar with the Trash Burn Pits indicate that disposal activities in this area ceased in the late 1980s.

7.1.0.4. Geology and Hydrology. As at the Main Demolition Area, soils underlying the Trash Burn Pits area have been mapped by the U.S. Soil Conservation Service as Hiko Peak Series and are composed of gravelly loams developed in alluvium from mixed rock types. Depth to bedrock in this area is generally greater than 700 feet. The depth to the regional groundwater table is over 700 feet based on a soil boring located immediately east of SWMU 1b, which was drilled to 709 feet bgs without encountering the water table (ERTEC, 1982). The soil types encountered in this boring are presented in the discussion of the Main Demolition Area (SWMU 1) in Section 5.0.

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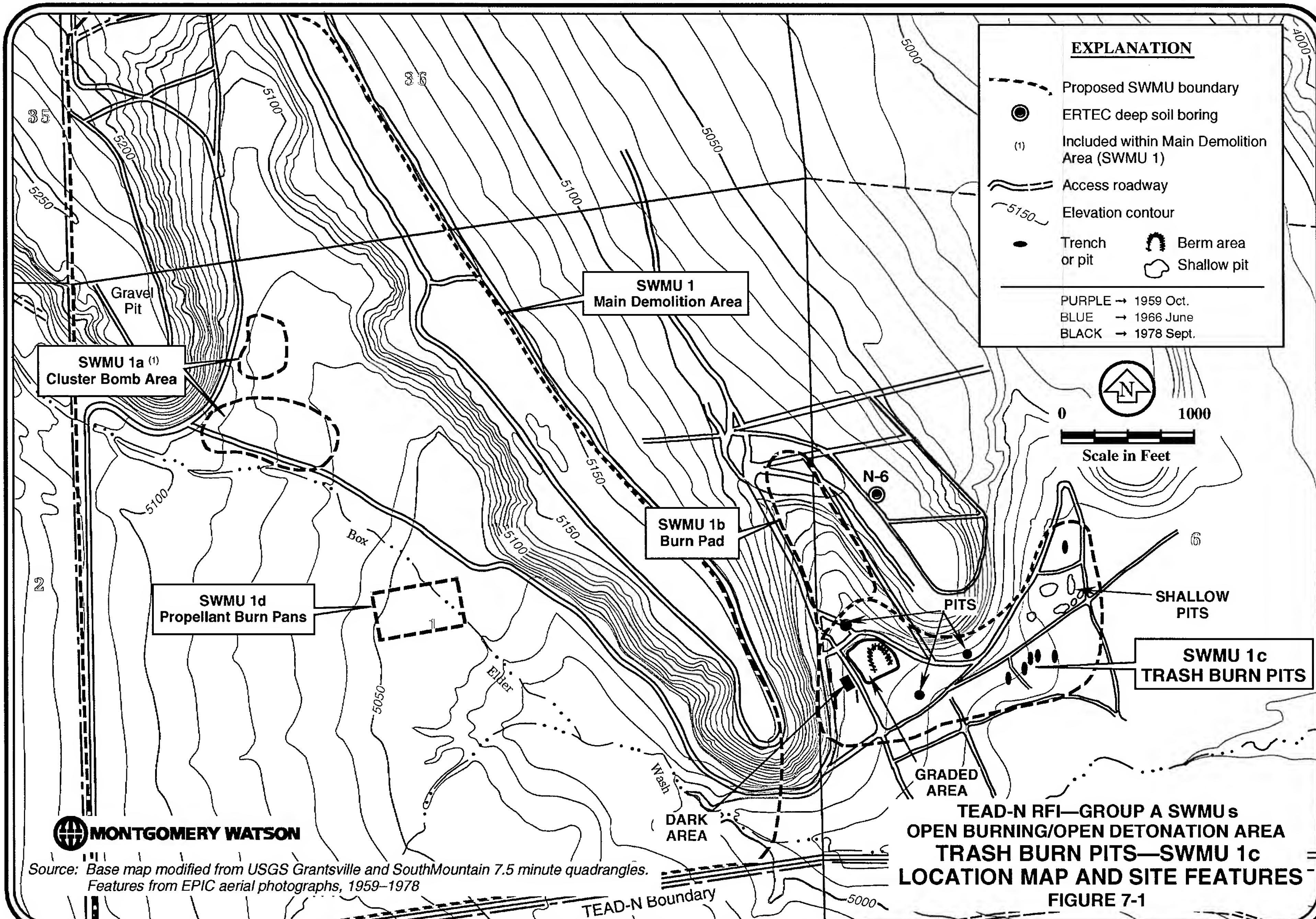

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Source: Base map modified from USGS Grantsville and SouthMountain 7.5 minute quadrangles. Features from EPIC aerial photographs, 1959–1978

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
TRASH BURN PITS—SWMU 1c
LOCATION MAP AND SITE FEATURES
FIGURE 7-1

7.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

7.2.1. Previous Investigations

7.2.1.1. Three samples, including one burn residue sample and two soil samples were collected from the Trash Burn Pits during the AEHA Phase II sampling. Samples were analyzed for EP Toxicity metals, RDX, HMX, 2,4,6-TNT, 2,4-DNT, and 2,6-DNT. Arsenic, barium, mercury, and 2,4,6-TNT were detected in the soil samples (AEHA, 1983). During Phase IV of the AEHA study, 36 soil samples were collected, including eight from surface soil sample locations and 28 from boreholes (down to 20 feet bgs) in the Trash Burn Pits area. Phase IV samples were analyzed for EP Toxicity metals, total metals (Pb, Cr, Cd, As, Ag, Ba, Hg, and Se), and explosives (HMX, RDX, 2,4,6-TNT, TETRYL, 2,4-DNT, and 2,6-DNT). All EP Toxicity results were below the detection limits. RDX was found in four of the surface soil samples (from 2.2 mg/kg to 14.9 mg/kg) and HMX was found in one surface soil sample (2.4 mg/kg). These results did not exceed the explosive compound guidelines (1,000 mg/kg) established for the AEHA study. Other compounds that were detected included several metals (As, Pb, Cr, Cd, and Ba). Results of this investigation suggest that the primary analytes of concern at this site are barium, lead, and cadmium. However, none of these compounds were detected at levels approaching present health-based guidance thresholds for soil such as EPA Region III Risk-Based Concentrations (USEPA, 1994a).

7.2.2. RFI Sampling Summary

7.2.2.1. Phase I Sampling. During the Phase I RFI twenty test pits were excavated, sampled, and logged. Two soil samples were collected from each test pit for a total of 40 samples. In addition, two 100-foot soil borings were drilled, with seven soil samples collected from various depths in each boring. All samples were analyzed for total metals, cyanide, explosive compounds, VOCs, SVOCs, and anions, and one selected sample of burn residue was submitted for dioxin/furan analysis. Four soil samples from this SWMU were submitted for explosive reactivity testing using the Gap Test and the Internal Ignition Test (USBM, 1988).

7.2.2.2. Phase II Activities. Data generated during the Phase I sampling at SWMU 1c were considered of sufficient quantity and quality to support a risk assessment. Therefore, no further sampling activities were conducted during the Phase II field

program. An ecological survey was conducted, however, to provide information to further help identify and quantify potential risks to the environment from this SWMU.

7.2.2.3. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that all of the SWMU 1c data are usable without qualification. Because no data for this SWMU were rejected, 100 percent completeness was achieved. Further details concerning the data review are presented in Appendix E of this document.

7.2.2.4. The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviations and the data quality objectives were met. Due to this, no data gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

7.3 CONTAMINATION ASSESSMENT

7.3.1. RFI Sampling Results

7.3.1.1. Surface Soils. Eight soil samples from SWMU 1c were collected from surface intervals in the test pits, and seven of these showed one or more elevated metals present. Of these, three of the surface samples had only slightly elevated levels of selenium (all less than 1 mg/kg). These concentrations could represent naturally-occurring background levels of this metal, even though they are above the statistically-generated upper threshold for background. The remaining four surface samples contained above-background amounts of barium, cadmium, copper, lead, silver, and/or zinc. Of the metals detected in the surface soils, only one cadmium result (44.5 mg/kg) exceeds the available risk-based guidance threshold for cadmium in residential soils of 39 mg/kg (USEPA, 1994a). Figure 7-2 presents the metals results for surface soils at SWMU 1c.

7.3.1.2. Two of the surface soil samples from the eastern side of the Trash Burn Pits contained RDX and HMX up to 47 mg/kg and 9.2 mg/kg, respectively. Both of the RDX concentrations are relatively high when compared to an available risk-based guidance threshold for RDX in commercial/industrial soils of 2.6 mg/kg. Two detections of tetrachloroethene (TCLEE) were present, but in very small quantities (less than 0.005 mg/kg). The detections of elevated levels of anions in the surface soils were generally limited to nitrates. Figures 7-3 and 7-4 show the analytical results for VOCs, SVOCs, explosives, dioxins/furans, and anions above background for both surface and

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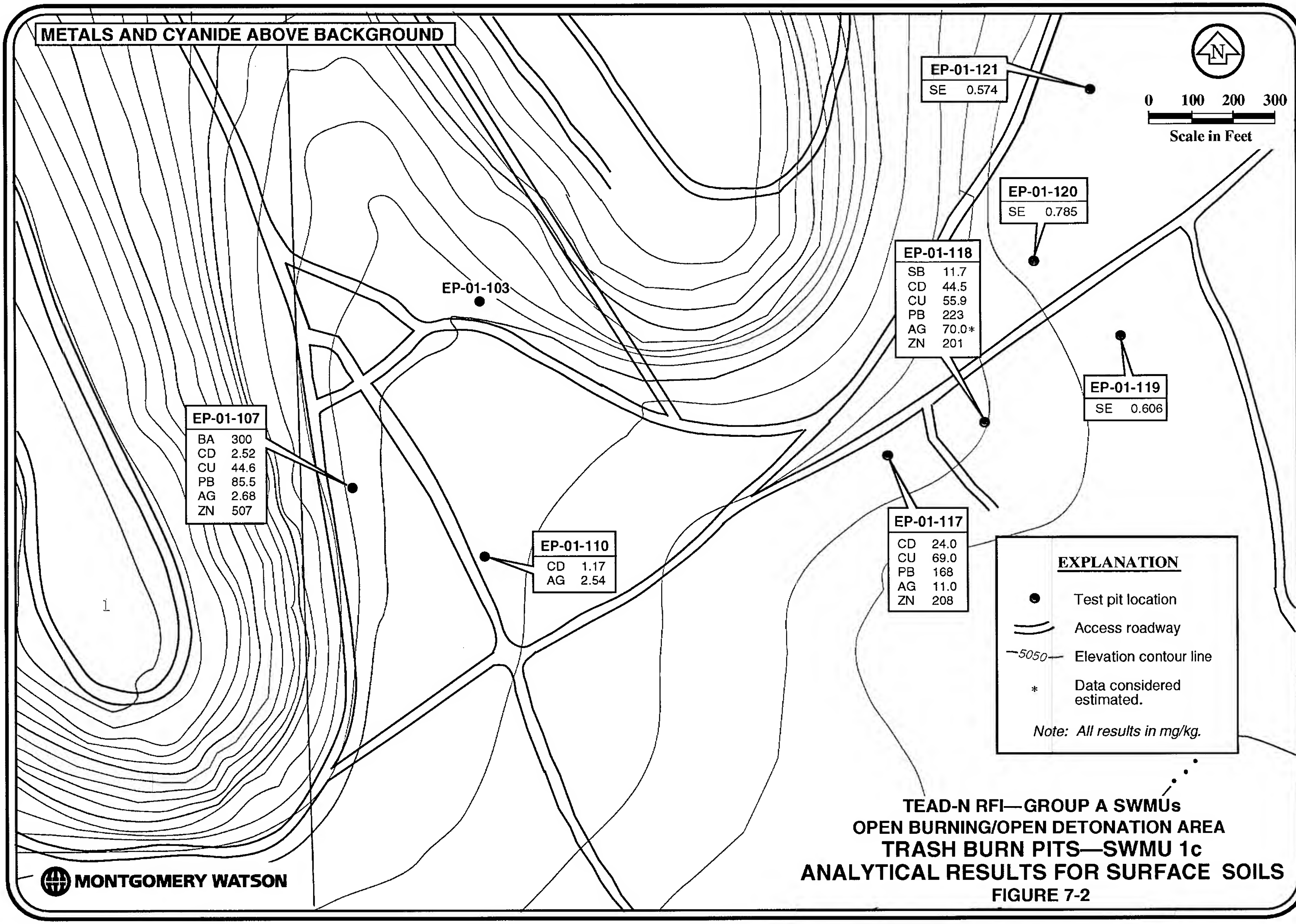
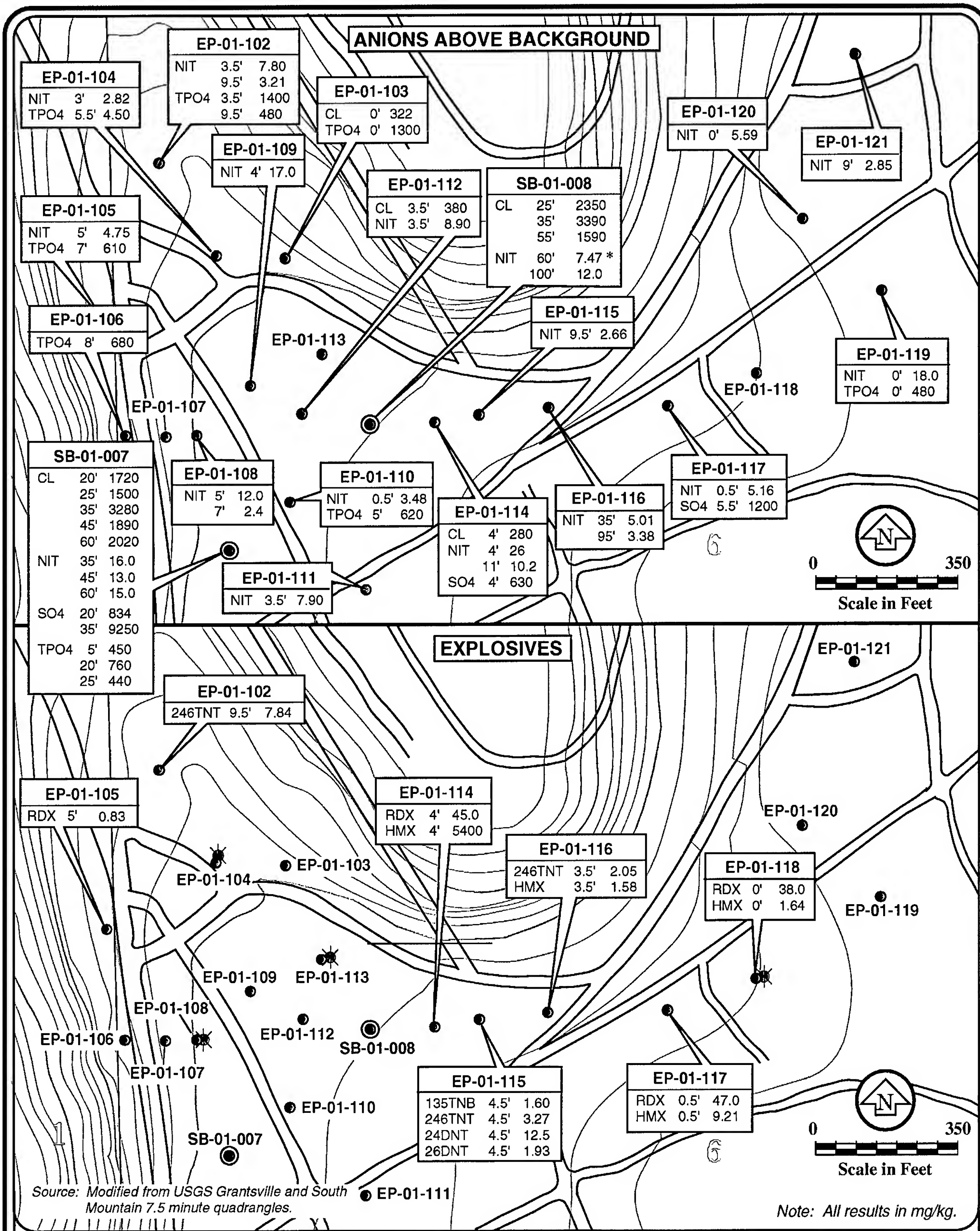


TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
TRASH BURN PITS—SWMU 1c
ANALYTICAL RESULTS FOR SURFACE SOILS
FIGURE 7-2



EXPLANATION

- Test pit location
- Explosive reactivity sample location
- Deep soil boring location
- Access roadway
- 5050 Elevation contour line
- * Data considered estimated. Refer to Appendix C.

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TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
TRASH BURN PITS—SWMU 1c
ANALYTICAL RESULTS FOR SURFACE AND SUBSURFACE SOILS
FIGURE 7-3

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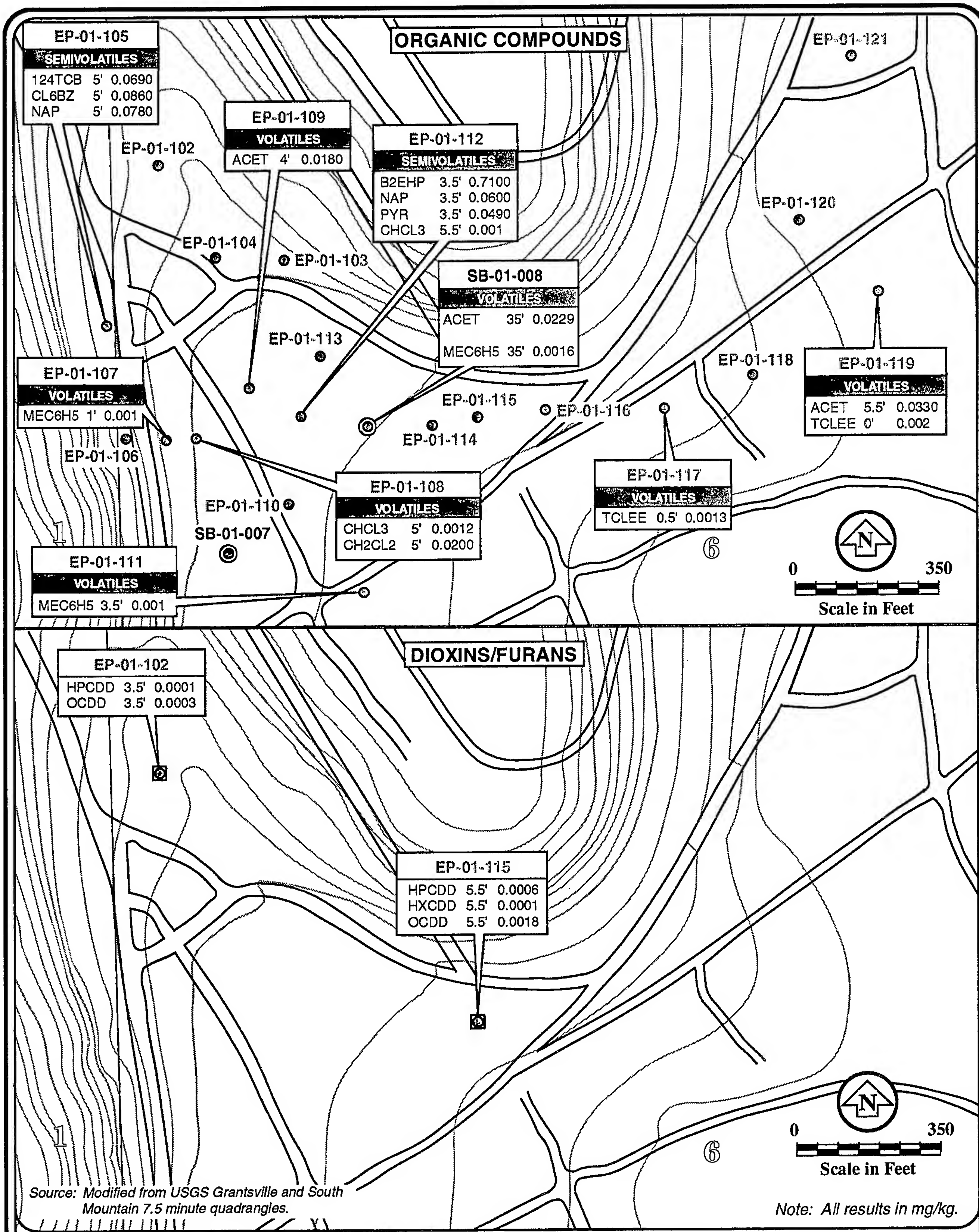

EXPLANATION

- Test pit location
- Test pit sampled for Dioxins/Furans
- Deep soil boring location
- Access roadway
- 5050 Elevation contour

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
TRASH BURN PITS—SWMU 1c
ANALYTICAL RESULTS FOR SURFACE AND SUBSURFACE SOILS
FIGURE 7-4

PROJECT NO. 2942.0190 10/23/95

subsurface soil (Section 4.1). Because of the sampling rationale for dioxins/furans at SWMU 1c (i.e., to preferentially sample areas of burned debris), and because no evidence of burned material was observed on the surface, only subsurface samples were collected.

7.3.1.3. Subsurface Soils. Several metals were detected at elevated levels in subsurface soil samples from the test pits (Figure 7-5). Many of these elevated metals results could be due to the fact that samples were generally collected from zones of ash and/or debris when encountered in the test pit; i.e., representing a worst-case scenario. Some above-background levels of mercury and selenium were detected in the 100-foot soil borings at SWMU 1c, although these may be due to naturally-occurring conditions in the deeper soils. All samples were also analyzed for the major anions, and some slightly elevated levels of nitrates/nitrites, chlorides, and total phosphates were found. It is not known if these analytes are naturally occurring soil constituents or the by-products of explosive compounds from the previous demilitarization activities conducted here.

7.3.1.4. Explosive compounds detected in the subsurface soils included RDX, 2,4,6-TNT, HMX, 2,4-DNT, 2,6-DNT, and 1,3,5-TNB. Comparison of the explosives results to the available risk-based guidance thresholds used here (USEPA, 1994a) shows that the levels of explosives are relatively low. Three detections of RDX exceed both the residential and commercial/industrial thresholds for soil (USEPA, 1994a). One of these samples yielded an HMX concentration of 5,400 mg/kg, but no risk-based guidance threshold for HMX has been established at this time.

7.3.1.5. Both of the subsurface soil samples submitted for dioxins/furans analysis showed trace amounts of dioxins, none of which exceeded the applicable risk-based guidance thresholds for these compounds. Volatile and semi-volatile organic compounds were detected in ten of the thirty-two subsurface soil samples from the test pits, and at a depth of 35 feet in one of the two soil borings. Toluene and acetone were detected in several samples, and chloroform, hexane, and methylene chloride were present in one sample. All VOCs were found in concentrations less than 1 mg/kg, and generally less than 0.1 mg/kg. The highest concentration for an SVOC was bis (2-ethylhexyl) phthalate at a concentration of 0.710 mg/kg in test pit EP-01-112. This level is well below the available risk-based soil guidance threshold of 85 mg/kg (USEPA, 1994a). Other SVOCs detected included naphthalene, 1,2,4-trichlorobenzene, hexachlorobenzene, and pyrene, all at concentrations below 0.1 mg/g. Of these compounds, only 1,2,4-trichlorobenzene and hexachlorobenzene have risk-based soil guidance thresholds established (780 mg/kg and 0.75 mg/kg, respectively). Several trace concentrations of the VOC trichloro-

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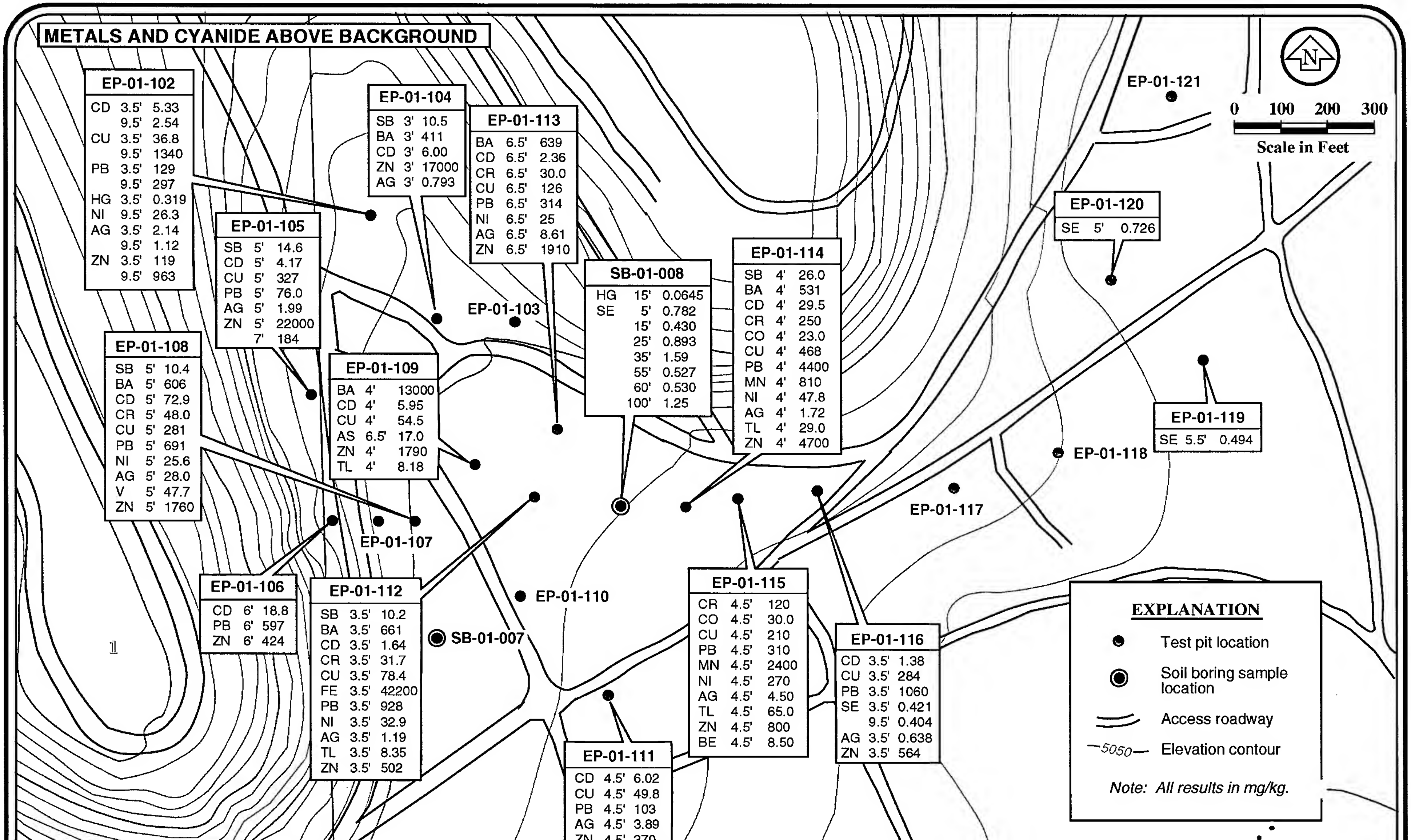

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
TRASH BURN PITS—SWMU 1c
ANALYTICAL RESULTS FOR SUBSURFACE SOILS
FIGURE 7-5

fluoromethane were detected in seven test pit samples, but have not been included here due to the probability that they resulted from laboratory contamination (e.g., a possible refrigerant leak).

7.3.2. Nature and Extent of Contamination

7.3.2.1. Evidence of burning and debris burial was seen in 15 of the 20 test pits excavated at the Trash Burn Pits, and sampling results have shown that release of contaminants to the surface and shallow subsurface soils has occurred. Elevated concentrations of several metals including cadmium, copper, silver, zinc, selenium, and lead were found in seven of the eight surface soils that were sampled, and in the majority of subsurface soils that were sampled. Many of the subsurface samples were collected judgmentally from areas of ash and debris noted in the test pits. The dioxins and furans detected in EP-01-102 (3.5' bgs) and EP-01-115 (5.5' bgs) were also from samples collected in debris zones, and represent a worst-case scenario. These PCDD/PCDF compounds may be the result of the burning of pentachlorophenol-treated packing crates. The results of the VOC, SVOC, anions, and explosives analyses are similar to the metals results, and show evidence of a contaminant release due to previous disposal activities at SWMU 1c.

7.3.2.2. The full horizontal and vertical extent of contamination has not been completely defined at this time. Relatively high levels of metals within burning and/or debris zones in the disposal trenches are present, but the lack of elevated metals, explosives, or significant organics contamination in the two 100-foot deep soil borings indicates that no widespread contamination exists at depth. The depth to groundwater and lack of a strong driving force make it unlikely that the groundwater underlying SWMU 1c has been impacted by the previous activities here.

7.3.3. Selection of COPCs and COPECs

7.3.3.1. Identification of COPCs. The selection of the COPCs for the Trash Burn Pits (SWMU 1c) was generally based on the screening procedures outlined in Section 3.2.6. As with SWMU 1b, the human exposure pathways evaluated involve only contact with the surface soil; therefore, only surface soil data were used in the COPC selection process. A summary of all chemicals detected in soil samples from SWMU 1c, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationales for the analytes not selected as COPCs are shown in Table 7-1.

TABLE 7-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN
FOR ANALYTES DETECTED IN SOIL AT SWMU 1c–TRASH BURN PITS

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluate in Risk Assessment?	
			Human	Ecological
Aluminum	1.70E+04	100	No (a)	No (a)
Antimony	**2.60E+01**	**14**	Yes	Yes
Arsenic	**1.70E+01**	**100**	Yes	No (a)
Barium	**1.30E+04**	**100**	Yes	Yes
Beryllium	**8.50E+00**	**40**	Yes	No (a)
Cadmium	**7.29E+01**	**37**	Yes	Yes
Chromium	**2.50E+02**	**91**	Yes	No (a)
Cobalt	3.00E+01	95	No (c)	Yes
Copper	6.92E+02	100	No (d)	Yes
Lead	**4.40E+03**	**100**	Yes	Yes
Manganese	**2.40E+03**	100	Yes	No (a)
Mercury	ND	0	No (a)	No (g)
Nickel	**2.70E+02**	**100**	Yes	No (a)
Selenium	7.82E-01	19	No (b)	No (e)
Silver	**7.00E+01**	**35**	Yes	Yes
Thallium	6.50E+01	9	Yes (g)	No (a)
Vanadium	4.77E+01	98	No (b)	Yes
Zinc	**2.20E+04**	**100**	Yes	Yes
1,2,4-Trichlorobenzene	6.90E-02	17	No (b)	No (e)
2,4,6-Trinitrotoluene	**5.05E+00**	**7**	Yes (g)	Yes
Acetone	3.30E-02	5	No (b)	No (e)
Bis(2-ethylhexyl)phthalate	7.10E-01	17	No (b)	No (e)
Cyclonite (RDX)	**4.70E+01**	**9**	Yes	No (e)
Cyclotetramethylenetetranitramine (HMX)	**5.40E+03**	**9**	Yes	No (e)
Dioxins	**4.44E-06 (f)**	**100**	Yes	No (e)
Hexachlorobenzene	8.60E-02	38	No (b)	Yes
Napthalene	7.80E-02	33	No (b)	No (e)
Pyrene	4.90E-02	17	No (b)	No (e)
Chloroform	1.00E-03	5	No (b)	No (e)
Methylene chloride	2.00E-02	3	No (b)	No (e)
Tetrachloroethene	2.00E-03	5	No (b)	No (e)
Toluene	1.00E-03	5	No (b)	No (e)

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium
Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

ND Not detected

(a) Analyte was detected at or below background concentrations in surface soil
(b) Analyte contributed less than 1 percent in a concentration - toxicity screen
(c) Low toxicity metal with inadequate toxicity data
(d) Analyte is an essential nutrient (see Section 3.2.6.)
(e) Maximum concentration is less than NOAEL or estimate of NOAEL
(f) Concentration based on toxicity equivalence factors
(g) Evaluate for scenarios involving subsurface soil only; not detected in surface soil

7.3.3.2. Chemicals of potential concern at SWMU 1c include the metals antimony, arsenic, barium, beryllium, cadmium, chromium, lead, manganese, silver, thallium, and zinc and the organic chemicals bis(2-ethylhexyl)phthalate, dioxins, HMX, RDX, and 2,4,6-TNT.

7.3.3.3. Identification of COPECs. The COPECs were selected based on the criteria outlined in the methodology discussion (Section 3.2.7.). The COPECs evaluated in Tier 2 and the reasons for the exclusion of analytes from further evaluation are presented in Table 7-1. The inorganic COPECs consist of antimony, barium, cadmium, cobalt, copper, lead, magnesium, vanadium, and zinc. The organic COPECs are 2,4,6-TNT and hexachlorobenzene.

7.3.4. Contaminant Fate and Transport

7.3.4.1. As discussed in Section 7.3.3., the contaminants of concern at SWMU 1c include metals, explosives, SVOCs, and dioxins (Table 7-1). Table 3-4 briefly describes the fate and transport characteristics for each of the contaminants of concern identified in Table 7-1. The remainder of this section presents a conceptual model of contaminant fate and transport at SWMU 1c and discusses the expected fate and transport of the contaminants of concern.

7.3.4.2. Conceptual Model. A conceptual site model of contaminant transport has been developed (Figure 7-6) based on the physical site characteristics presented in Section 2.0 and the contamination assessment presented above. This model displays the potential migration routes of contaminants from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear unlikely based on available data. Contamination has been released to the surface and subsurface soils at SWMU 1c from disposal, open burning, and burial of a variety of waste materials. The surface soils and shallow soils at SWMU 1c consist of sand, silty sand, and clay; groundwater is greater than 700 feet bgs and surface runoff is toward the south-southeast to Box Elder Wash.

7.3.4.3. Fate and Transport of Metals. Based on the known current conditions at SWMU 1c, it appears unlikely that metals would migrate to the groundwater. Transport

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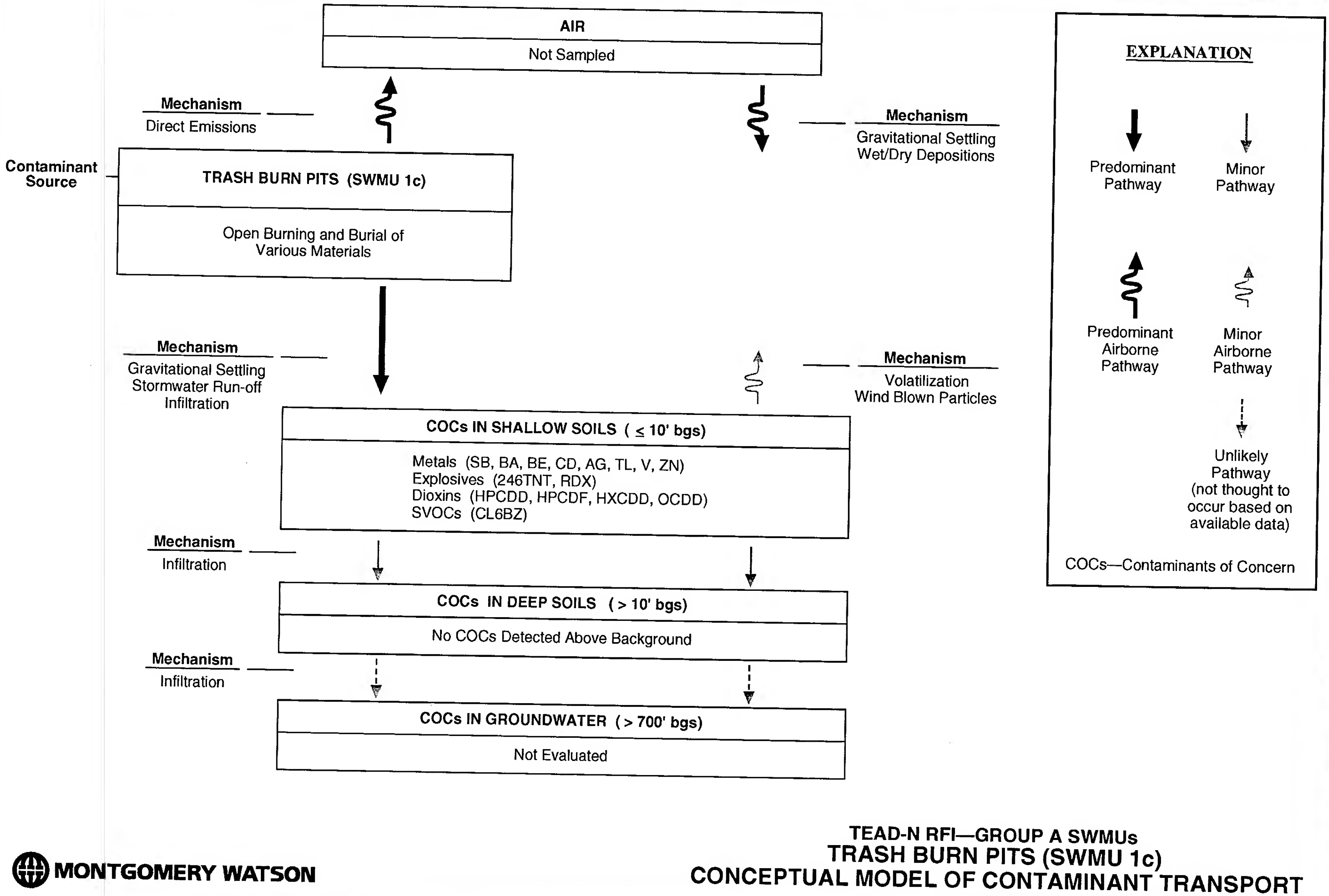

TEAD-N RFI—GROUP A SWMUs
TRASH BURN PITS (SWMU 1c)
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 7-6

of metals from the surface soils through the deeper soil horizons to groundwater is not expected based on the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow soils, neutral to slightly basic pH soils and depth to groundwater (more than 700 feet bgs). Samples collected from deep soil borings drilled to 100 feet bgs in this area indicate that elevated metals concentration do not extend below 10 feet bgs. Off-site migration of metal contaminants via surface-water pathway appears to be minimal based on soil samples collected in Box Elder Wash, down-gradient of the Trash Burn Pits. The metal contaminants at the surface may provide particulates to the air pathway.

7.3.4.4. Fate and Transport of Explosives. Concentrations of explosives have been detected as high as 5400 mg/kg at four feet bgs, which suggests there may be a potential for leaching into deeper soil horizons since explosive compounds in the environment are generally mobile. However, it is unlikely that the explosives would be transported to groundwater depth (over 700 feet bgs), due to the low precipitation rates and high evaporation rates. Vadose zone contaminant transport modeling by RUST (1994) has shown that it would take over 100 years for these contaminants to migrate 300 vertical feet, and the resulting concentration at this depth would be orders of magnitude less than the current concentrations in the soil. Attenuation of the explosive concentrations in surface soils can be expected through slow volatilization or by slow photolytic transformations. In subsurface soils, explosives attenuate by very slow biodegradation.

7.3.4.5. Fate and Transport of Dioxins. Dioxins and furans are expected to strongly adsorb to soil and sediment. As a result, they are likely to be immobile in most soils. They will not leach to groundwater and will probably not migrate more than a few feet into subsurface soil horizons. Surface water runoff will have very limited transport effects because these contaminants strongly adsorb to sediments and precipitation rates are low. Dioxins at the surface may provide particulates to the air pathway. Both dioxins and furans are persistent in the environment.

7.3.4.6. Fate and Transport of SVOCs. Hexachlorobenzene was detected in only one test pit (EP-01-105) at a low concentration, so it is of limited importance to the overall fate and transport of the COPCs at SWMU 1c. This compound is expected to strongly sorb to soils and be persistent in the environment. It will resist leaching, volatilizing to the atmosphere, and biodegradation. Hexachlorobenzene at the surface may provide particles to the airborne pathway. Surface water transport is not considered to be an important pathway.

7.4 HUMAN HEALTH RISK ASSESSMENT

7.4.0.1. The methods used to estimate the risks associated with SWMU 1b are given in Human Health Risk Assessment Methodology, Section 3.2.6. The COPCs were identified in the preceding section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 1c) are presented in the following sections.

7.4.1. Exposure Pathways and Receptors

7.4.1.1. The pathways quantitatively evaluated in the BRA are: (1) those that are complete or likely to be completed in the future, and (2) those that may potentially cause a significant risk. A diagram of exposure pathways for SWMU 1c is shown on Figure 7-7. An evaluation of exposure pathway completeness and an assessment of whether the pathway is significant enough to require further evaluation for current and potential future receptors at SWMU 1c is given in Tables 7-2 and 7-3, respectively.

7.4.1.2. Current receptors at SWMU 1c include security personnel and other people who periodically monitor the area. Potential future on-Depot receptors for contaminants originating at SWMU 1c include construction workers. As shown in the exposure pathway diagram (Figure 7-7), construction workers can be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For future construction workers, direct exposure results from the anticipated excavation activities associated with construction, and includes subsurface soil as well as surface soil. Because of the remoteness of this SWMU, the presence of unexploded ordnance, the large areas of undeveloped land on the Depot, and the presence of adequate OB/OD facilities, future development of this area by the Depot is not foreseen. Although future scenarios involving construction workers are unlikely, this scenario has been evaluated to provide a benchmark for contaminants in near-surface soil.

7.4.1.3. Should this portion of the Depot be closed in the future (it is not slated for closure at this time), future residents could also become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. However, their contact would be confined to contaminants in surface soil. It should be noted that a residential development is unlikely. Even if the Depot is closed, the remote nature of SWMU 1c would tend to preclude residential development. However, because of the requirements of UAC 315-101 (1994), a residential scenario was evaluated.

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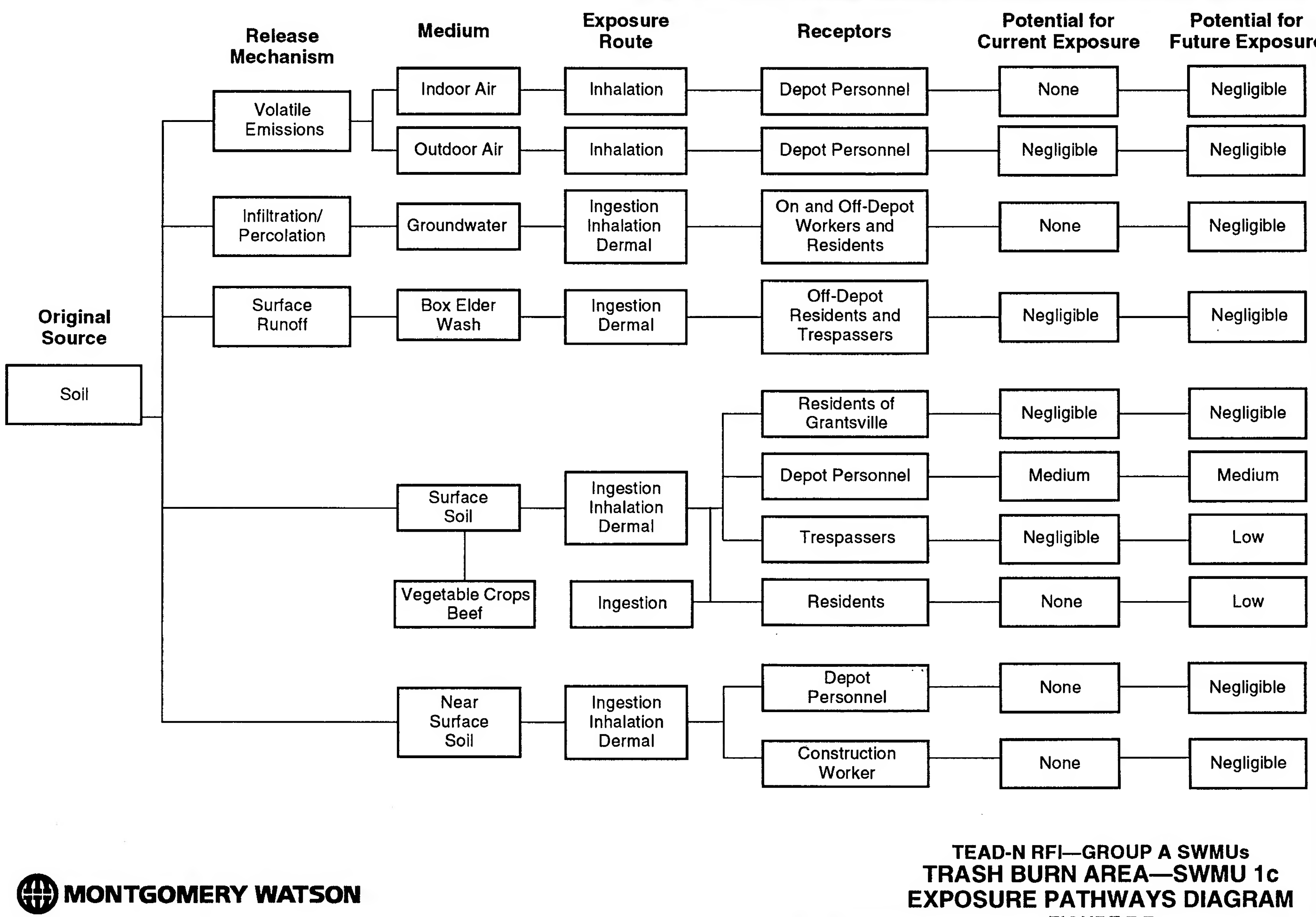

TEAD-N RFI—GROUP A SWMUs
TRASH BURN AREA—SWMU 1c
EXPOSURE PATHWAYS DIAGRAM
FIGURE 7-7

TABLE 7-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 1c: TRASH BURN PITS

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is about 700 feet below ground surface. Soil samples from 10 feet to the maximum depth explored of 100 feet below ground surface were not contaminated.
Surface Water and Sediment			
Box Elder Wash	Trespasser and off-Depot residents	Incidental ingestion and dermal contact with water or sediment	No. Only rarely is there water in the wash. Samples collected from the wash were not contaminated.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. Emissions are anticipated to be small because SWMU 1c is much smaller than SWMU 1 (and has a comparable level of contamination) where this pathway showed no potential for significant risk.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. No evidence of trespassers, i.e. no tracks or sightings.
	Depot security personnel	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Security personnel periodically inspect this area.
Air	Depot security personnel	Inhalation of volatile organics from subsurface soil	No. Volatile organics were not detected. Dust exposure evaluated under soil.

TABLE 7-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 1c: TRASH BURN PITS

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely to result in the future. Groundwater is over 700 feet below the below ground surface and evapotranspiration is high.
Surface Water and Sediment			
Box Elder Wash	Trespassers and future residents	Incidental ingestion, dermal contact with water or sediment	No. Only rarely is there water in the wash. Samples collected from the wash were not contaminated and this SWMU is no longer active.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. Emissions are anticipated to be small because SWMU 1c is much smaller than SWMU 1 (and has a comparable level of contamination) where this pathway showed no potential for significant risk.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Although a future residential scenario is unlikely because the Depot does not anticipate closing this area; this pathway will be evaluated.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Future trespassers will have less exposure than a resident.
	Depot security personnel	Incidental ingestion of dust, inhalation, and dermal contact	No. Exposure will be the same as that evaluated under current conditions.

TABLE 7-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 1c: TRASH BURN PITS
(Continued)

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Near-surface Soil	Construction worker	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Although future scenarios involving construction workers are unlikely, this scenario has been evaluated to provide a risk benchmark for contaminants in near-surface soil. This SWMU is in a remote area of the Depot where there are no buildings and where unexploded ordnance is present. Intrusive activities would be inherently risky. The Depot has large areas of undeveloped land and can build outside of this SWMU more cheaply. All OB/OD activities can be conducted within permitted areas. Use of SWMU 1b for OB/OD activities would require a RCRA Part B permit.
Air	Depot security personnel	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and will not increase in the future because these SWMUs are no longer active. Dust exposure evaluated under soil.

TEAD-N Tooele Army Depot North Area

7.4.1.4. SWMU 1c could be converted into an area where crops are grown. However, efforts to grow vegetables in soil from adjacent areas failed (Rust E&I, 1995). The experiments included soil from an area where there was no known release of hazardous chemicals. It was concluded that the salt content of the soil was "toxic", and that vegetables could not be grown without leaching salt from the soil. Although such activities are considered unlikely, this pathway is evaluated as part of the future residential scenario.

7.4.1.5. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. This pathway is also evaluated as part of the future residential scenario.

7.4.1.6. For the pathways that were evaluated quantitatively (see Tables 7-2 and 7-3), site specific values or, where unavailable, EPA defaults were used to estimate COPC intakes. The parameters used in estimating intakes are presented in Appendix K.

7.4.2. Risk Characterization

7.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 1c. The methods for calculating the risks are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

7.4.2.2. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable, a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these two values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects may be possible. An adult blood lead level between 10 and 15 micrograms per deciliter (μg/dl) is a benchmark range based on hypertension in adult males and transfer of lead from a pregnant mother to her fetus. For children, 10 μg/dl is the benchmark typically used by the EPA (USEPA, 1994) (see Section 3.2.6 for a discussion of the calculation of blood lead concentrations for adults and children).

7.4.2.3. In addition to the calculated estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for security personnel and potential future residents.

7.4.2.4. Security Personnel. Depot security personnel were assumed to be potentially exposed to COPCs in the surface soil. The security personnel were assumed to visit the SWMU once per week for one hour. The personnel were assumed to patrol the SWMU inside of a vehicle. The estimates of risk for security personnel are presented in Table 7-4.

7.4.2.5. For SWMU 1c, the calculated excess lifetime cancer risk for security personnel is 1×10^{-6}. The cancer risk results principally from dermal exposure to RDX, a Class C (possible human) carcinogen. This pathway has a low to moderate potential to be completed because the security personnel are likely enclosed in a vehicle. The quantitative risk estimates and qualitative factors related to the risk estimates are summarized in Table 7-5.

7.4.2.6. The total hazard index for security personnel was estimated to equal 0.03 (Table 7-4). This hazard index indicates that health effects are unlikely. While the inhalation pathway was not quantitatively evaluated for the COPCs due to the absence of inhalation reference doses, the exposure doses are low enough for the other COPCs such that there is a low potential for toxic effects (see the discussion of uncertainties in Section 7.4.3.).

7.4.2.7. The concentration of lead in blood was estimated to be 3.9 µg/dl and is more representative of a full time worker exposure. This concentration is less than the benchmark range of 10 to 15 µg/dl, and indicates that security workers are not at risk from exposure to lead.

TABLE 7-4

SWMU 1c - TRASH BURN PITS
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR SECURITY PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	5.14E+00	6E-08	3E-08	7E-09	1E-07	7
Beryllium	8.58E-01	3E-08	2E-07	6E-10	2E-07	18
Cadmium	2.30E+01	NC	NC	1E-08	1E-08	<1
Chromium(VI)	7.60E-01	NC	NC	3E-09	3E-09	<1
Cyclonite (RDX)	2.76E+01	2E-08	9E-07	NC	9E-07	68
Dioxins/Furans	4.44E-06	5E-09	7E-08	6E-11	7E-08	5
Pathway Total		1E-07	1E-06	2E-08		
Percent of Total		8	90	2		
			Total Cancer Risk:		**1E-06**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	6.99E+00	3E-04	1E-02	NC	2E-02	54
Arsenic	5.14E+00	3E-04	1E-04	NC	5E-04	2
Barium	1.60E+02	4E-05	4E-04	4E-05	5E-04	2
Beryllium	8.58E-01	3E-06	3E-05	NC	3E-05	<1
Cadmium	2.30E+01	5E-04	3E-03	NC	3E-03	12
Chromium (VI)	7.60E-01	3E-06	1E-05	NC	1E-05	<1
Chromium (III)	1.44E+01	3E-07	3E-06	NC	3E-06	<1
Lead	1.35E+02	NC	NC	NC	NC	NC
Manganese	3.74E+02	5E-05	7E-04	6E-03	7E-03	26
Nickel	1.32E+01	1E-05	6E-05	NC	7E-05	<1
Silver	3.11E+01	1E-04	5E-04	NC	6E-04	2
Zinc	1.48E+02	1E-05	1E-05	NC	2E-05	<1
Cyclonite (RDX)	2.76E+01	2E-04	3E-04	NC	4E-04	2
HMX	4.22E+00	2E-06	5E-06	NC	6E-06	<1
Pathway Total		2E-03	2E-02	6E-03		
Percent of Total		6	71	23		
			Total Hazard Index:		**3E-02**	
	Blood Lead Concentration µg/dl (95th percentile):				**3.5**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 7-5

TEAD-N BASELINE RISK ASSESSMENT
SWMU 1c–TRASH BURN PITS PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (μg/dl)	Key Chemicals[a]
Security Personnel					3.5	
Ingestion	Current moderate	Medium/High	0.001	3×10^{-8}		Cadmium, cyclonite (RDX), antimony, beryllium, manganese
Dermal	Current moderate	High/Neutral-High	0.03	1×10^{-6}		
Inhalation	Current moderate	High/High	NC	1×10^{-8}		
Construction Worker					4.2	
Ingestion	Future unlikely	High/High	0.2	7×10^{-7}		Arsenic, beryllium, manganese
Dermal	Future unlikely	High/High	0.08	6×10^{-8}		
Inhalation	Future unlikely	High/High	3	3×10^{-7}		
TEAD-N Resident					6.9	
Ingestion	Future unlikely	Medium/High	0.7	6×10^{-6}		Cyclonite (RDX)
Dermal	Future unlikely	High/Neutral-High	0.3	7×10^{-6}		
Inhalation	Future unlikely	High/High	NC	7×10^{-7}		
Vegetable Crops	Future unlikely	High/High	1,000	9×10^{-2}		
Beef	Future unlikely	High/Neutral	0.0002	2×10^{-8}		

TEAD-N Tooele Army Depot North Area

NC Not calculated

(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

7.4.2.8. Potential Future Construction Worker. Potential future construction workers are assumed to be exposed to COPCs in the soil from a depth of 0 to 12 feet during excavation activities. The estimated excess lifetime cancer risk was 1 x 10^{-6} (Table 7-6). Most of the cancer risk is from the ingestion and inhalation of arsenic and ingestion of beryllium. Arsenic is a Class A (known human) carcinogen which adds to the significance of the risk estimates, although its carcinogenicity was identified at very high exposure doses that may not be relevant here. Despite the presence of arsenic, site-related cancer risks are expected to be less than 1 x 10^{-6} for two reasons. First, arsenic was evaluated as a COPC, but may not actually be present above background levels. In the near-surface soil (0-12 feet) arsenic was detected at concentrations above the background threshold concentration of 16 mg/kg in only 1 of 43 samples, and at a maximum detected concentration of 17 mg/kg. Because the statistical background threshold is expected to be exceeded in five percent of the samples when a metal is at background concentrations, the calculated risk for a construction worker from arsenic (7 x 10^{-7}) is probably a background risk. The second reason to expect actual risks to be less than 1 x 10^{-6} is that likely overestimates in soil ingestion rates and dust concentrations (See Section 7.4.3) indicate that more accurate estimates of these parameters would reduce the cancer risk to less than 1 x 10^{-6} regardless of the anthropogenic or non-anthropogenic nature of the source. The likelihood of this hypothesis is further suggested by a cancer risk estimate of 3 x 10^{-7} using CTE parameters (see Table 7-7).

7.4.2.9. The total hazard index for potential construction workers was estimated to equal 3, and the concentration of lead in blood was estimated to be 4.2 μg/dl (Table 7-6). The blood lead concentration is below the benchmark range of 10 to 15 μg/dl. The hazard index of 3 is dominated by inhalation of manganese in dust. Manganese, with an exposure point concentration of 389 mg/kg, is at a concentration less than the average manganese concentration in the Western United States (Shacklette and Boerngen, 1984). If these workers are at risk from manganese exposure, then most workers in the Western United States that experience high levels of dust (such as construction workers) are at a similar or higher risk. An estimate of the hazard index using CTE parameters equaled 1 (Table 7-7).

7.4.2.10. The inhalation exposure pathway has not been fully accounted for in the hazard index due to the absence of inhalation reference doses for several of the COPCs. However, the exposure doses of most COPCs are in a range where adverse health effects

TABLE 7-6

SWMU 1c - TRASH BURN PITS
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	7.94E+00	5E-07	4E-09	2E-07	7E-07	60
Beryllium	1.04E+00	2E-07	3E-08	1E-08	2E-07	18
Cadmium	9.09E+00	NC	NC	8E-08	8E-08	7
Chromium (VI)	1.46E+00	NC	NC	8E-08	8E-08	8
RDX	6.17E+00	2E-08	2E-08	NC	4E-08	4
2,4,6-Trinitrotoluene	6.42E-01	6E-10	2E-10	NC	9E-10	<1
Dioxins	4.44E-06	2E-08	7E-09	9E-10	3E-08	3
Pathway Total		7E-07	6E-08	3E-07		
Percent of Total		63	5	32		
			Total Cancer Risk:		**1E-06**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	6.54E+00	4E-02	3E-02	NC	7E-02	2
Arsenic	7.94E+00	6E-02	6E-04	NC	6E-02	2
Barium	9.71E+02	3E-02	6E-03	1E-01	1E-01	4
Beryllium	1.04E+00	5E-04	9E-05	NC	6E-04	<1
Cadmium	9.09E+00	2E-02	3E-03	NC	2E-02	<1
Chromium (VI)	1.46E+00	2E-04	1E-05	NC	2E-04	<1
Chromium (III)	2.77E+01	6E-06	1E-06	NC	8E-06	<1
Lead	4.07E+02	NC	NC	NC	NC	NC
Manganese	3.89E+02	7E-03	2E-03	3E+00	3E+00	87
Nickel	2.77E+01	3E-03	3E-04	NC	4E-03	<1
Silver	6.38E+00	3E-03	3E-04	NC	3E-03	<1
Thallium	8.17E+00	2E-02	2E-04	NC	2E-02	<1
Zinc	2.43E+03	2E-02	6E-04	NC	2E-02	<1
HMX	3.37E+02	2E-02	3E-02	NC	4E-02	1
RDX	6.17E+00	5E-03	4E-03	NC	9E-03	<1
2,4,6-Trinitrotoluene	6.42E-01	3E-03	1E-03	NC	4E-03	<1
Pathway Total		2E-01	8E-02	3E+00		
Percent of Total		8	3	90		
			Total Hazard Index:		**3E+00**	
	Blood Lead Concentration µg/dl (95th percentile):				**4.2**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 7-7

SWMU 1c - TRASH BURN PITS
CTE CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	7.94E+00	1E-07	8E-10	7E-08	2E-07	60
Beryllium	1.04E+00	4E-08	5E-09	5E-09	5E-08	15
Cadmium	9.09E+00	NC	NC	3E-08	3E-08	9
Chromium (VI)	1.46E+00	NC	NC	3E-08	3E-08	10
RDX	6.17E+00	6E-09	4E-09	NC	1E-08	3
2,4,6-Trinitrotoluene	6.42E-01	2E-10	4E-11	NC	2E-10	<1
Dioxins	4.44E-06	6E-09	1E-09	4E-10	8E-09	2
Pathway Total		2E-07	1E-08	1E-07		
Percent of Total		56	3	41		
			Total Cancer Risk:		**3E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	6.54E+00	1E-02	6E-03	NC	2E-02	1
Arsenic	7.94E+00	2E-02	1E-04	NC	2E-02	1
Barium	9.71E+02	9E-03	1E-03	4E-02	5E-02	4
Beryllium	1.04E+00	1E-04	2E-05	NC	2E-04	<1
Cadmium	9.09E+00	6E-03	5E-04	NC	6E-03	<1
Chromium (VI)	1.46E+00	5E-05	2E-06	NC	5E-05	<1
Chromium (III)	2.77E+01	2E-06	3E-07	NC	2E-06	<1
Lead	4.07E+02	NC	NC	NC	NC	NC
Manganese	3.89E+02	2E-03	3E-04	1E+00	1E+00	90
Nickel	2.77E+01	9E-04	5E-05	NC	1E-03	<1
Silver	6.38E+00	8E-04	5E-05	NC	9E-04	<1
Thallium	8.17E+00	7E-03	4E-05	NC	7E-03	<1
Zinc	2.43E+03	5E-03	1E-04	NC	5E-03	<1
HMX	3.37E+02	4E-03	5E-03	NC	9E-03	<1
RDX	6.17E+00	1E-03	8E-04	NC	2E-03	<1
2,4,6-Trinitrotoluene	6.42E-01	8E-04	2E-04	NC	1E-03	<1
Pathway Total		7E-02	1E-02	1E+00		
Percent of Total		6	1	93		
			Total Hazard Index:		**1E+00**	
	Blood Lead Concentration µg/dl (50th percentile):				**2.4**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

are unlikely (see the discussion of uncertainties in Section 7.4.3.; Appendix K summarizes the exposure doses).

7.4.2.11. Hot spot risk analyses were performed separately for potential future construction workers at tests pits EP-01-108 and EP-01-109, and test pits EP-01-114 and EP-01-115. These pairs of test pits are close together, and generally contain higher concentrations of contaminants than other test pits at this SWMU. Because only four samples were collected from each of these hot spots, maximum concentrations of COPCs detected in the hot spots were used in the risk calculations. The same exposure parameters were used in the hot spot evaluation as were used in the overall risk analysis for this SWMU, except the exposure frequency was reduced from 125 days per year to 12.5 days per year. This adjustment is a proportional reduction in the exposure frequency, based on exposure to an area represented by two test pits, rather than 20 test pits.

7.4.2.12. At the EP-01-108 and EP-01-109 hot spot, the estimated lifetime cancer risk is 2×10^{-7}, the hazard index is 0.5, and the blood lead concentration is 4.8 µg/l (see Table 7-8). The hazard index and cancer risk are lower than those calculated for the overall SWMU (see Table 7-6). The estimated blood lead concentration is greater than that for the overall SWMU, but below the benchmark range of 10 to 15 µg/dl.

7.4.2.13. At the EP-01-114 and EP-01-115 hot spot, the estimated lifetime cancer risk is 4×10^{-7}, the hazard index is 2, and the blood lead concentration is 12.4 µg/l (see Table 7-9). The estimate cancer risk and hazard index are lower than those calculated for the overall SWMU (see Table 7-6). The estimated blood lead concentration is greater than that calculated for the overall SWMU, and within the benchmark range of 10 to 15 µg/dl. Because the lead model assumes steady-state conditions but a 12.5-day exposure frequency may be to short to reach these conditions, the significance of the calculated blood lead concentration is low. Consequently, these two pairs of trenches do not require different consideration with respect to potential corrective measures than SWMU 1c as a whole.

7.4.2.14. Potential Future TEAD-N Resident. Potential future residents at TEAD-N were assumed to be exposed to COPCs in the surface soil from a depth of 0 to 0.5 feet. The cancer risk from all exposure pathways was estimated to equal 9×10^{-2}, and the hazard index was estimated to equal 1,000. The excess lifetime cancer risk from potential exposure to soil was estimated to be 1×10^{-5} (Table 7-10). Most of the risk is

TABLE 7-8

SWMU 1c - TRASH BURN PITS
TEST PITS EP-01-108 AND EP-01-109 HOT SPOT
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.70E+01	1E-07	9E-10	4E-08	1E-07	60
Beryllium	7.66E-01	1E-08	2E-09	9E-10	1E-08	6
Cadmium	7.29E+01	NC	NC	6E-08	6E-08	28
Chromium (VI)	2.40E+00	NC	NC	1E-08	1E-08	6
RDX	ND	NC	NC	NC	NC	NC
2,4,6-Trinitrotoluene	ND	NC	NC	NC	NC	NC
Dioxins	NA	NC	NC	NC	NC	NC
Pathway Total		1E-07	3E-09	1E-07		
Percent of Total		49	1	50		
			Total Cancer Risk:		**2E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	1.04E+01	6E-03	5E-03	NC	1E-02	2
Arsenic	1.70E+01	1E-02	1E-04	NC	1E-02	2
Barium	1.30E+04	4E-02	8E-03	1E-01	2E-01	33
Beryllium	7.66E-01	4E-05	6E-06	NC	4E-05	<1
Cadmium	7.29E+01	2E-02	2E-03	NC	2E-02	4
Chromium (VI)	2.40E+00	3E-05	2E-06	NC	3E-05	<1
Chromium (III)	4.56E+01	1E-06	2E-07	NC	1E-06	<1
Lead	6.91E+02	NC	NC	NC	NC	NC
Manganese	4.52E+02	8E-04	2E-04	3E-01	3E-01	58
Nickel	2.56E+01	3E-04	3E-05	NC	3E-04	<1
Silver	2.80E+01	1E-03	1E-04	NC	1E-03	<1
Thallium	8.18E+00	2E-03	2E-05	NC	2E-03	<1
Zinc	1.79E+03	1E-03	4E-05	NC	1E-03	<1
HMX	ND	NC	NC	NC	NC	NC
RDX	ND	NC	NC	NC	NC	NC
2,4,6-Trinitrotoluene	ND	NC	NC	NC	NC	NC
Pathway Total		9E-02	2E-02	4E-01		
Percent of Total		16	3	81		
			Total Hazard Index:		**5E-01**	
	Blood Lead Concentration µg/dl (95th percentile):				**4.8**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 7-9

SWMU 1c - TRASH BURN PITS
TEST PITS EP-01-114 AND EP-01-115 HOT SPOT
RME CANCER RISK. HAZARD INDEX. AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.20E+01	7E-08	6E-10	3E-08	1E-07	26
Beryllium	8.50E+00	1E-07	2E-08	1E-08	2E-07	40
Cadmium	2.95E+01	NC	NC	3E-08	3E-08	7
Chromium (VI)	1.25E+01	NC	NC	7E-08	7E-08	19
RDX	4.50E+01	2E-08	1E-08	NC	3E-08	8
2,4,6-Trinitrotoluene	3.27E+00	3E-10	1E-10	NC	4E-10	<1
Dioxins	4.44E-06	2E-09	7E-10	9E-11	3E-09	<1
Pathway Total		2E-07	4E-08	1E-07		
Percent of Total		56	10	34		
			Total Cancer Risk:		**4E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	2.60E+01	2E-02	1E-02	NC	3E-02	2
Arsenic	1.20E+01	9E-03	8E-05	NC	9E-03	<1
Barium	5.31E+02	2E-03	3E-04	5E-03	7E-03	<1
Beryllium	8.50E+00	4E-04	7E-05	NC	5E-04	<1
Cadmium	2.95E+01	7E-03	9E-04	NC	8E-03	<1
Chromium (VI)	1.25E+01	1E-04	1E-05	NC	2E-04	<1
Chromium (III)	2.38E+02	6E-06	1E-06	NC	7E-06	<1
Lead	4.40E+03	NC	NC	NC	NC	NC
Manganese	2.40E+03	4E-03	1E-03	2E+00	2E+00	91
Nickel	2.70E+02	3E-03	3E-04	NC	3E-03	<1
Silver	4.50E+00	2E-04	2E-05	NC	2E-04	<1
Thallium	6.50E+01	2E-02	2E-04	NC	2E-02	1
Zinc	4.70E+03	4E-03	1E-04	NC	4E-03	<1
HMX	5.40E+03	3E-02	5E-02	NC	7E-02	4
RDX	4.50E+01	4E-03	3E-03	NC	7E-03	<1
2,4,6-Trinitrotoluene	3.27E+00	2E-03	5E-04	NC	2E-03	<1
Pathway Total		9E-02	7E-02	2E+00		
Percent of Total		5	4	91		
			Total Hazard Index:		2E+00	
		Blood Lead Concentration µg/dl (95th percentile):			**12.4**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 7-10

SWMU 1c - TRASH BURN PITS
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	5.14E+00	1E-05	2E-07	4E-07	3E-05	3E-09	5E-05	<1
Beryllium	8.58E-01	6E-06	2E-06	4E-08	3E-06	9E-10	1E-05	<1
Cadmium	2.30E+01	NC	NC	7E-07	NC	NC	7E-07	<1
Chromium (VI)	7.60E-01	NC	NC	2E-07	NC	NC	2E-07	<1
Cyclonite (RDX)	2.76E+01	5E-06	6E-06	NC	9E-02	1E-11	9E-02	100
Dioxins/Furans	4.44E-06	1E-06	5E-07	3E-09	8E-06	2E-08	9E-06	<1
Pathway Total		3E-05	9E-06	1E-06	9E-02	3E-08		
Percent of Total		<1	<1	<1	100	<1		
					Total Cancer Risk:		**9E-02**	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	6.99E+00	2E-01	1E-01	NC	2E+00	4E-05	2E+00	<1
Arsenic	5.14E+00	2E-01	1E-03	NC	3E-01	4E-05	5E-01	<1
Barium	1.60E+02	3E-02	4E-03	5E-02	1E-01	7E-07	2E-01	<1
Beryllium	8.58E-01	2E-03	3E-04	NC	7E-04	3E-07	3E-03	<1
Cadmium	2.30E+01	3E-01	3E-02	NC	6E+00	2E-05	6E+00	<1
Chromium (VI)	7.60E-01	2E-03	1E-04	NC	7E-04	4E-07	3E-03	<1
Chromium (III)	1.44E+01	2E-04	3E-05	NC	6E-05	4E-08	3E-04	<1
Lead	1.35E+02	NC	NC	NC	NC	NC	NC	NC
Manganese	3.74E+02	3E-02	8E-03	8E-01	3E-01	3E-06	1E+00	<1
Nickel	1.32E+01	8E-03	6E-04	NC	1E-02	2E-06	2E-02	<1
Silver	3.11E+01	8E-02	5E-03	NC	NC	NC	8E-02	<1
Zinc	1.48E+02	6E-03	1E-04	NC	NC	7E-05	7E-03	<1
Cyclonite (RDX)	2.76E+01	1E-01	8E-02	NC	1E+03	3E-07	1E+03	97
HMX	4.22E+00	1E-03	1E-03	NC	3E+01	1E-09	3E+01	2
Pathway Total		1E+00	3E-01	8E-01	1E+03	2E-04		
Percent of Total		<1	<1	<1	100	<1		
					Total Hazard Index:		**1E+03**	

Blood Lead Concentration µg/dl (95th percentile): 6.9

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure
TEAD-N Tooele Army Depot North Area

from the ingestion and dermal exposure to RDX. RDX is a Class C (possible human) carcinogen, which implies that its potential for human carcinogenicity is uncertain. Considering only the uncertainties in the exposure parameters, the cancer risk estimate of 1×10^{-5} is probably high, and may be closer to (or below) 1×10^{-6} (see Section 7.4.3. for a discussion of the uncertainties). The significance of the risk estimates is diminished because the potential for pathway completeness is low.

7.4.2.15. The total hazard index for potential future child residents potentially exposed to soil at TEAD-N is estimated to be 1, and the blood lead concentration to be 6.9 µg/dl. The blood lead concentration is lower than the concentration at which adverse health effects have been observed in children. The hazard index of 1 probably does not indicate a potential for adverse effects, given the uncertainties in the exposure evaluation (Section 7.4.3.).

7.4.2.16. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 1c, the estimated cancer risk is 9×10^{-2} and the hazard index is 1,000 (Table 7-10), primarily due to the explosives RDX and HMX. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has several orders of magnitude of uncertainty because of uncertainties in the plant uptake factors (see Section 7.4.3.). If plants metabolize explosives (which is not accounted for in the uptake model), the risks from explosives via this pathway would be low. Because of the high degree of uncertainty, the significance of these risk estimates is unknown.

7.4.2.17. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 1c, the estimated cancer risk is 2×10^{-8} and the hazard index is 0.0002 (Table 7-10). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 1c if they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

7.4.3. Uncertainties

7.4.3.1 The exposure estimates and toxicity values have associated uncertainties, the magnitude and nature of which affect the confidence in the results. Most of the uncertainties are such that risk estimates could be lower than estimated, but are unlikely to be higher. The following paragraphs discuss uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor which focus on elements contributing the most to overestimates of the total risk, and on those elements where risks may be underestimates. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk.

7.4.3.2. The exposure point concentrations (concentrations of chemicals in an environmental medium at the point where a receptor is exposed) used in the risk calculations were based, in part, on judgmental sampling (i.e., sampling designed to find the highest concentrations of chemicals). Where observed, samples were collected from, or immediately below, stained soil or debris within trenches where munitions or other waste were burned. Because trenches occupy only a portion of this SWMU, and because soil in or beneath stained areas would tend to represent the most contaminated area of the trench, the exposure point concentrations are considered representative of the most contaminated areas present, rather than for the SWMU as a whole.

7.4.3.3. Dioxins/furans are formed from burning chlorinated solvents. Because the trenches where these compounds were detected were not sampled for dioxins/furans, dioxin/furan concentrations in some burn pits may be higher than the detected concentrations. This would result in underestimating the risks associated with these compounds. Because deposition from the burning would also lead to surface soil contamination, surface soil risks cannot be ruled out. However, for reasons discussed in Section 6.4.3.3, dioxin/furan concentrations in surface soil will likely be much lower than in the burn trenches.

7.4.3.4. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having

additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

7.4.3.4. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical (tetraethyl lead) with a reference dose below 1×10^{-6} mg/kg/day , and this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation of metals with exposure doses greater than 1×10^{-6} was examined on a case-by-case basis. The results of this evaluation were presented in Section 7.4.2. Exposure doses are summarized in Appendix K.

7.4.3.5. Security Personnel. Because no significant risks were associated with security personnel, those components of the risk calculations which may underestimate risk are the only components which require discussion. The primary parameter which may have been underestimated is the fraction of the contaminant absorbed through the skin (referred to as the dermal absorption factor). Dermal absorption factors depend on the individual properties of a chemical, but well-conducted experiments designed to determine these values have only been carried out for a few compounds (USEPA, 1992) and, consequently, the absorption factors used in the BRA could be under- or overestimates. If the RDX absorption factor is higher than the assumed three percent, then the dermal risk could exceed 1×10^{-6}. However, the exposure estimates likely overestimate the risk because it was assumed that the guards' hands, arms, and face were covered with soil, which is unlikely given the guards' activity and mode of transportation. Uncertainties in the dermal risk for other COPCs are less likely to affect the overall risk estimate than those for RDX. Uncertainties related to the absorption factor are low for dioxins, as these compounds have been well studied (USEPA, 1992). The estimated risks for other organic compounds are low enough such that even the assumption of 100 percent absorption would not result in a respective benchmark being exceeded. The dermal pathway for metals is expected to be minor relative to ingestion

due to their poor absorption through the skin (USEPA, 1992). Consequently, overall risk estimates are not greatly affected by uncertainties in the dermal risk estimates for metals.

7.4.3.6. Potential Construction Workers. Uncertainties associated with the exposure dose for a construction worker are high. As discussed in Section 5.0, a reasonable ingestion rate is probably a factor of 3.5 less than the 480 mg/day used in this risk assessment. Also the bioavailability of the contaminants in the soil is likely to be less than the 100 percent assumed for the BRA, further reducing the actual dose and corresponding risk. The BRA assumed a dust concentration of 1 mg/m^3, which is the upper end of the range of dust levels measured while digging test pits at SWMU 1 (although most of the time dust levels were lower).

7.4.3.7. Future Potential TEAD-N Residents. The uncertainties for security personnel also apply to the evaluation of future residents (not considering the likelihood of this area actually becoming residential). However, because the cancer risk was greater than 1×10^{-6}, potential overestimates deserve further evaluation. In a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure, and (to a lesser extent) reduces the potential for dermal and ingestion exposure. The concentration of RDX (which accounts for most of the risk) used in the calculations was over half the maximum detected concentration. Because RDX was only detected in nine percent of the samples, it is likely that the exposure point concentration is an overestimate of the average. Uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the dust level, and dermal uncertainties are derived from the skin surface area and the fraction of chemicals absorbed. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who intentionally eat soil) consume unusually large amounts of soil. Consequently, the ingestion rate in most children would be overestimated but a small percentage of children may exceed the assumed rate of 200 mg/day.

7.4.3.8. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

7.4.3.9. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53.

7.4.3.10. There is even greater uncertainty at SWMU 1c. The estimated risks for the produce exposure pathway are dominated by RDX and HMX. However, the equation used to estimate the plant uptake factors from the log K_{ow} was developed using mostly data for pesticides, which are very different from explosives; a poorer fit would be expected for explosives than for compounds used to develop the relationship. The plant uptake model also does not account for metabolism of the chemical by the plant. Based on their polar structure, it would not be surprising if plants metabolize RDX and HMX, thus eliminating exposure to explosives by humans through this pathway. In addition, because the salt content of the soil is currently toxic to plants (see Section 7.4.1.4.), the soil would need to be diluted with peat or other soil amendments to grow produce. This has not been accounted for in the exposure calculations. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

7.4.4. Recommendations

7.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Permit construction work at this site only if conducted in accordance with OSHA hazardous waste operations.

- Evaluate the need for institutional controls and/or corrective action in a Corrective Measures Study should this land no longer be controlled by the depot.

Note that the recommendation for unrestricted land use is made solely with respect to human health risks from chemical toxicity. Restrictions are recommended based on the potential for explosive risks, as discussed in Section 7.6.

7.5 ECOLOGICAL RISK ASSESSMENT

7.5.0.1. This section discusses the results of the Tier 1 and Tier 2 evaluations. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4.

7.5.1. Tier 1

7.5.1.1. Ecological Receptors. The majority of SWMU 1c has been disturbed and currently supports both native and weedy, introduced species. The SWMU is dominated by weedy species with occasional big sagebrush. The weedy species in the previously disturbed areas consist of cheatgrass, Russian thistle, annual sunflower, storksbill, blobemallow and gumweed. Scattered Utah juniper and big sagebrush are also present in the area. The mapped range and soil type are:

Range Site: Semi-Desert Gravelly Loam
Soil Type: Hiko Peak gravelly loam with 2-15 percent slopes.

7.5.1.2. Expected Climax Vegetation. The range site describes the climax vegetation expected to occur at each site due to the combined influence of environmental factors characteristic for the site. Observed dominant vegetation in undisturbed areas includes big sagebrush, Douglas rabbitbrush, needle-and-thread grass, Indian ricegrass, and sand dropseed. These species are the expected dominant vegetation for this range site (USSCS, 1991).

7.5.1.3. Wildlife. No reptiles were observed at SWMU 1c but, based on sightings elsewhere at the Depot, the collared and side-blotched lizard, the western whiptail, the Great Basin rattlesnake and the gopher snake may be inhabitants at or near SWMU 1c.

7.5.1.4. Although no small mammals were observed at SWMU 1c, rabbit pellets from black-tailed jackrabbits and the cottontail rabbits were observed, as well as valley pocket gopher mounds. Based on observations elsewhere at the Depot and the type of habitat, the common small mammal species that are probable inhabitants at SWMU 1b include the Ord's kangaroo rat, the deer mouse, Great Basin pocket mouse, pinyon mouse, sagebrush vole, the desert woodrat, and the little pocket mouse (Burt and Grossenheider,

1980; RUST, 1994). There is no evidence from the field surveys that large mammals are present at SWMU 1c. However, large mammals such as the coyote (personal communication, Dr. J. Merino), pronghorn antelope, and mule deer may occur at SWMU 1c on an intermittent basis.

7.5.1.5. Raptors such as the golden eagle, American kestrel, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, red-tailed hawk, and the great-horned owl have been observed in other areas of TEAD-N but not at SWMU 1c. Because of the typical range of these species during foraging/hunting activities, raptors may be present at SWMU 1c on an intermittent basis.

7.5.1.6. No passerine or other birds were observed during the site visit. The sage grouse, a State of Utah sensitive species, may inhabit the undisturbed areas of the SWMU. Many other potential non-game birds such as crows and several families of passerine birds would be expected.

7.5.1.7. Results of the Tier 1 Ecological Assessment. The field surveys indicated that the vegetation at SWMU 1c has been impacted to a greater degree by the physical activities at the site (i.e., burning and clearing activities) than by the chemicals that may have been released. The ecological assessment, therefore, addresses the potential adverse impact to the wildlife receptors and it is not deemed necessary to address the ecological effects on the vegetation. The ecological assessment is performed with the assumption that the wildlife receptors are not limited by the physical boundaries of the SWMU, i.e., the spatial distribution of the chemicals detected at SWMU 1c is assumed to potentially expose the wildlife species that occur or that may potentially occur on the TEAD-N facility as a whole. The results of the Tier 1 assessment indicate that the detected levels of some of the chemicals at SWMU 1c warrant a Tier 2 evaluation.

7.5.2. Tier 2

7.5.2.1. The objective of the Tier 2 assessment is to further evaluate the Tier 1 COPECs by comparing the receptor's chemical exposure dose to a biological endpoint.

7.5.2.2. Exposure Analysis. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil; indirect exposure occurs via the food web, such as when a raptor consumes a mouse. Since

SWMU 1c has no surface water, the surface water exposure pathway is incomplete and is not included in the ecological assessment.

7.5.2.3. The reptiles potentially inhabiting SWMU 1c could be exposed via direct pathways (ingestion and dermal exposure to soil) and, to a lesser extent, via food web pathways (e.g. ingestion of contaminated insects). As prey, they may also expose predators.

7.5.2.4. Small mammals are exposed predominantly via direct pathways (ingestion of soil) and, to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators.

7.5.2.5. The antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing) and, as prey, may expose predators. The coyote (a predator) is exposed predominantly via food web pathways unless their den is located in contaminated soil, which may then cause a significant direct exposure by soil ingestion.

7.5.2.6. The predominant route of exposure for the raptors is via food web pathways because they typically do not spend much time on the ground. The non-raptor birds are exposed via food web pathways by ingestion of seeds and grasses, and by direct exposure to soil during preening.

7.5.2.7. Risk Characterization. The ecological COPECs at SWMU 1c are based on the ecological toxicity quotient derived by comparing either the dose ingested by the indicator species or the chemical concentration in the soil to a biological endpoint. The ingestion pathway is associated with the greatest exposure at TEAD-N. The results indicate that barium, cadmium, lead, silver, thallium, and vanadium are the inorganic COPECs in the surface soil (0-6") that have ETQs greater than 1.0. A similar suite of COPECs are present in the subsurface soil, except that zinc is present rather than vanadium. These estimated ETQs, however, are overestimations due to the uncertainties in the evaluation. The calculations were done with the assumption that the foraging area of the receptors is exclusively within the contaminated area at SWMU 1c. This conservative assumption leads to a contaminant intake or dose that is significantly higher than what is actually being ingested by the receptors. The results of the ecological evaluation are presented in Appendix K.

7.5.2.8. When the foraging area exceeds the contaminated area, a correction factor that accounts for less than full-time exposure is required (deSesso, 1994). The mobility factor is a suggested method for estimating the fraction of time that a receptor may be exposed to a contaminant. The mobility factor is the ratio of the contaminated area to the foraging area and accounts for the effect of receptor mobility to the frequency and duration of exposure to the contaminated media. The areal extent of SWMU 1c is very small relative to the foraging area of the selected indicator species, thus significantly reducing the ETQs and diminishing the potential for adverse impacts to the ecological receptors. The receptors that may have a high exposure are the less mobile receptors such as reptiles or small mammals. The field surveys did not observe these species at SWMU 1c, but the ecological assessment identifies them as potentially occurring at the site. The impact to less mobile terrestrial receptors at SWMU 1c is not significant enough to adversely affect the structure and function of the ecosystem due to the limited number of individuals potentially affected based on the size of the SWMU.

7.5.2.9. The relatively low bioaccumulative potentials for the metals retained for the ecological evaluation make the potential for impacts to higher predator trophic levels unlikely. Therefore, it is recommended that SWMU 1c be proposed for no further investigation with respect to the potential for ecological effects.

7.5.2.10. Uncertainties. The evaluation does not take into account the frequency of exposure to the contaminant nor the effect of receptor mobility on the frequency and duration of contact with the contaminated media. The use of NOAEL-type values as surrogates for effective concentration is significantly more conservative as an indicator of risk. The use of NOAEL-type values assumes 100 percent bioavailability of the contaminants. For soil, 100 percent bioavailability is likely an overestimate for most contaminants.

7.5.3. Recommendations

7.5.3.1. Based on the preceding discussions, SWMU 1c is recommended for no further investigation regarding potential ecological effects.

7.6 DETERMINATION OF EXPLOSIVE RISK

7.6.1. Potentially Explosive Munitions Items

7.6.1.1. During the field investigation period of August 6-11, 1992, the UXO subcontractor found the following ordnance types and uncased explosives in or near the Trash Burn Pits, Tooele Army Depot North (TEAD-N):

- 75mm projectile
- 81mm mortar
- 90mm projectile
- 105mm projectile
- 105mm projectile
- BLU 4
- BLU 4 fuze
- 3.5-inch rocket fuze
- 5.0-inch rocket fuze
- Projectile fuze with booster
- M557 PD fuze
- Non-electric blasting cap
- Anti-tank mine
- Anti-tank mine fuze
- Flare, M125

7.6.2. Risk Interpretation

7.6.2.1. Although this area is currently not in use, access should be restricted to properly trained personnel who are familiar with the appropriate safety precautions and are trained to recognize ordnance and explosives. Should this site be designated as lease grazing land or have the potential for cattle to stray into the area, the explosives hazards could endanger ranchers tending the cattle or rounding up stray cattle. If the ranchers were on foot (outside of a vehicle or off horseback) in the Trash Burn Pit area they would be in greater danger due to closer proximity to the hazardous items and lack of barrier protection offered by a vehicle or horse.

7.6.3. Recommendations

7.6.3.1. Based on the preceding discussions, the following recommendations are made:

- Conduct a surface UXO clearance as soon as possible to remove the sensitive items such as blasting caps and fuzes.

- Continue to restrict access to the Trash Burn Pits to ordnance personnel employed by TEAD-N. Before conducting any activity, these personnel should conduct a surface and subsurface UXO clearance in this area to avoid unintentionally detonating ordnance.

- Provide UXO clearance of any work or sampling sites prior to performing environmental field activities in the Trash Burn Pits area.

- Prior to releasing the land for grazing, perform ordnance clearance on 100 percent of the area to a depth of 12 inches.

8.0 PROPELLANT BURN PANS (SWMU 1d)

8.1 SITE BACKGROUND

8.1.0.1. Site Description. The Propellant Burn Pans (SWMU 1d) consists of an area of approximately 650 feet by 350 feet which has been cleared of vegetation and equipped with 15 steel "pans". The pans are of two sizes; three are 8 feet by 4 feet by 1 foot deep and the other twelve are 16 feet by 4 feet by 1 foot. During normal operations, the facility is used in the early spring to late fall up to four to five times per week. Sometimes as many as ten burnings a week may take place. SWMU 1d is located in the same erosional valley as the Main Demolition Area (SWMU 1; Figure 8-1). No permanent structures are present other than the steel pans.

8.1.0.2. Operational Activities. Bulk propellant scheduled for disposal is loaded into the pans and ignited with timer fuses. Up to 1,000 pounds of propellant may be burned in any one of the large pans and up to 600 pounds may be burned in any one of the small pans. The operating permit for SWMU 1d requires that less than 10,000 pounds of propellant per hour be burned. Under normal operations 9,000 pounds of propellant are burned per day of operation (usually in two separate burns). The propellant materials burn down to a fine ash, which is then containerized and handled as a hazardous waste. The propellant handling and burning is conducted according to all U.S. Army Environmental Hygiene Agency (AEHA) recommended best management practices (AEHA, 1987). The pans are covered between burns to prevent precipitation from accumulating in them. The only types of material treated at SWMU 1d are bulk propellants, consisting of nitrocellulose base, and gun and Howitzer propellants. The propellant burn pans were not in operation prior to the late 1980s (Rutishauser, 1990).

8.1.0.3. Geology and Hydrology. The soils underlying the Propellant Burn Pans have been mapped by the U.S. Soil Conservation Service as Hiko Peak Series, and are composed of gravelly loams developed in alluvium from mixed rock types. Depth to bedrock in this area is generally greater than 700 feet. The depth to the regional groundwater table is over 700 feet based on a soil boring located east of SWMU 1d, which was drilled to 709 feet bgs without encountering the water table (ERTEC, 1982). The soil types encountered in this boring are presented in the discussion of the Main Demolition Area (SWMU 1) in Section 5.0.

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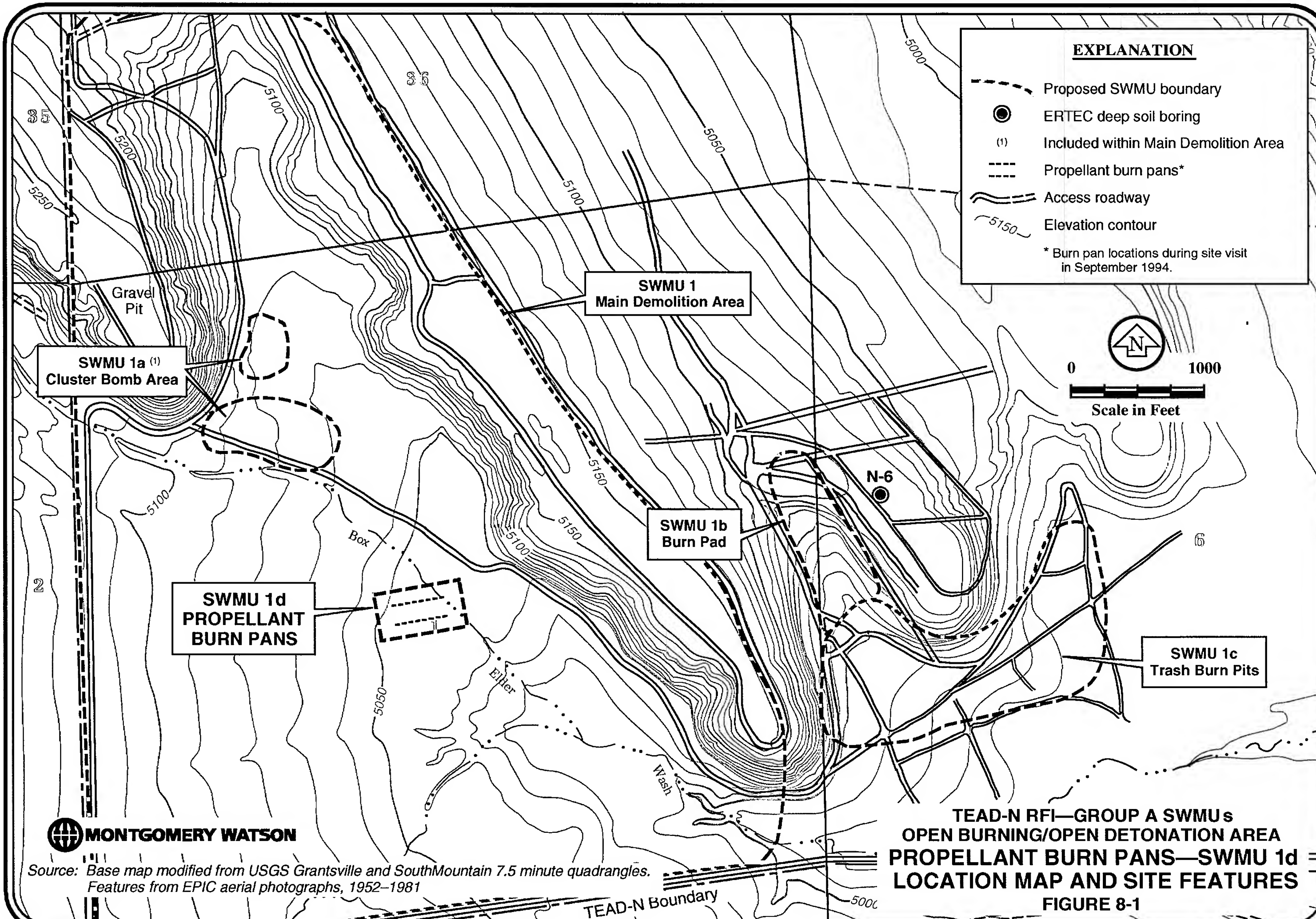


Source: Base map modified from USGS Grantsville and SouthMountain 7.5 minute quadrangles.
Features from EPIC aerial photographs, 1952–1981

TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA
PROPELLANT BURN PANS—SWMU 1d
LOCATION MAP AND SITE FEATURES
FIGURE 8-1

8.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

8.2.1. Previous Investigations

8.2.1.1. No sampling activities have been conducted at SWMU 1d prior to the Phase I RFI except as associated with the larger OB/OD Area. AEHA collected and analyzed several soil samples from the OB/OD Area during the period 1981-84, but available documents do not identify the exact locations of these samples. The Propellant Burn Pans were not in operation prior to the late 1980s (Rutishauser, 1990).

8.2.2. RFI Sampling Summary

8.2.2.1. Phase I Sampling. Seven test pits were excavated, sampled, and logged at the Propellant Burn Pans during the Phase I RFI. The test pits were excavated adjacent to and between the steel burn pans, and two soil samples were collected from each test pit for a total of 14 samples. In addition, one 100-foot soil boring was drilled and seven soil samples were collected from various depths in the boring. All samples were analyzed for total metals, cyanide, explosive compounds, and anions. Two samples (one surface soil and one subsurface soil) were also submitted for VOC and SVOC analyses, and two soil samples from this SWMU were submitted for explosive reactivity testing using the Gap Test and the Internal Ignition Test (USBM, 1988).

8.2.2.2. Phase II Activities. Since SWMU 1d currently operates under RCRA Part B interim status, the decision was made by both Army and regulatory personnel to defer further environmental sampling until future RCRA closure activities. This avoided redundancy of effort, since the delineation of any contaminant release will be required at that time. To assist in the risk assessment for SWMU 1d, an ecological survey of the Propellant Burn Pans area was conducted as part of the Phase II activities at TEAD-N.

8.2.2.3. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that all of the SWMU 1c data are usable without qualification. Because no data for this SWMU were rejected, 100 percent completeness was achieved. Further details concerning the data review are presented in Appendix E of this document.

8.2.2.4. The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviations and the data quality objectives

were met. Due to this, no data gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

8.3 CONTAMINATION ASSESSMENT

8.3.1. RFI Sampling Results

8.3.1.1. Surface Soils. Surface soil samples were collected from each of the seven test pit locations. Of the 14 test pit samples (seven surface and seven subsurface samples) submitted for metals analysis, only the surface soil samples contained elevated levels of metals, indicating that the metals contamination is generally limited to the ground surface. The metal detected at the highest concentrations at SWMU 1d was lead, with detections ranging up to 2,030 mg/kg. The elevated concentrations of lead in the surface soils are probably related to the presence of lead azide in the propellants that are burned. Elevated levels of beryllium above the available risk-based guidance threshold for both residential and commercial soils (USEPA, 1994a) were present in two of the surface soil samples, but these levels are below the RFI statistically-generated background level for beryllium in TEAD-N coarse-grained soils. Thallium was also present above the guidance threshold for a residential soil of 6.3 mg/kg in two surface soil samples and two subsurface samples. The deep soil boring (SB-01-005) showed concentrations of selenium above background. This is not believed to be related to SWMU 1d activities, since no selenium above background was detected in the shallower test pit soil samples.

8.3.1.2. Six of the seven surface soil samples from the test pits contained explosive compounds, with 2,4-DNT detected in all six samples up to a concentration of 17.3 mg/kg. Of the two soil samples submitted for explosive reactivity, neither was thermally sensitive or shock sensitive. No explosive compounds were detected in the subsurface soils.

8.3.1.3. No volatile or semi-volatile organic compounds were detected in either of the two samples submitted for these analyses, with one exception. Butyl phthalate was detected in the surface soil sample from test pit EP-01-088 at less than 1 mg/kg. This result is thought to be a product of laboratory contamination, rather than an indication of a contaminant release (see Section 3.2.4.4.), and has not been included as part of the contamination assessment.

8.3.1.4. All samples were analyzed for the major anions, and elevated levels of nitrates/nitrites, total phosphates, sulfates, and chloride were present in all of the test pits. Unlike the metals and explosives, elevated levels of these anions were found in both surface and subsurface soils.

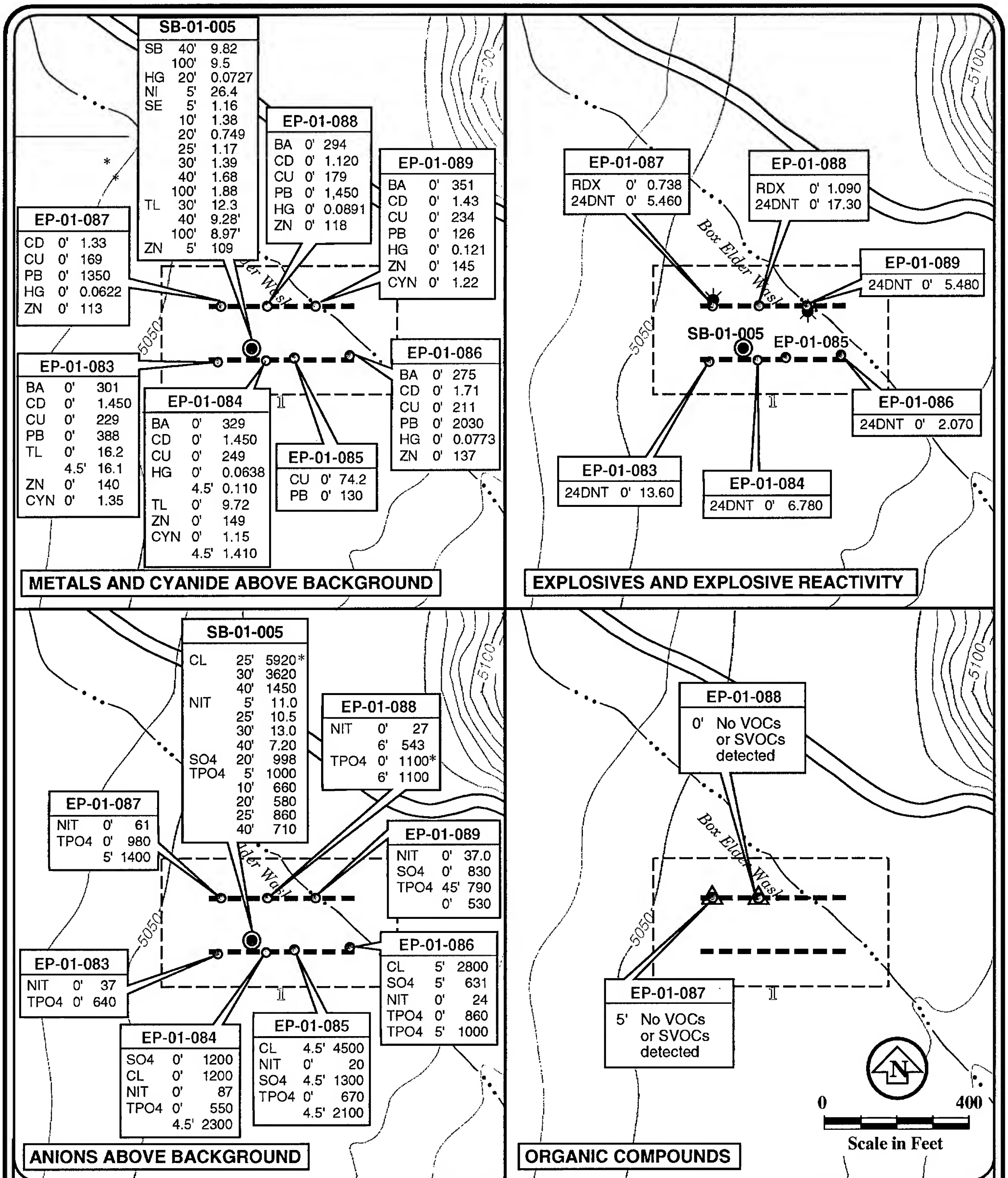
8.3.1.5. Subsurface Soils. Elevated metals in subsurface soils were limited to the deep soil boring at SWMU 1d, and concentrations of nitrates/nitrites, total phosphates, and chloride above the background thresholds were also detected to about 40 feet bgs in the deep soil boring. Although the levels of these anions and metals are above the upper thresholds determined for background conditions, they could be due to naturally-occurring conditions in the deeper soils.

8.3.1.6. Figure 8-2 shows the surface and subsurface analytical results for metals, cyanide, explosives, organics, and anions. The sample depths are noted next to the respective results.

8.3.2. Nature and Extent of Contamination

8.3.2.1. In general, elevated metals and explosives are present at SWMU 1d in the surface soils, and probably originate from the open burning of propellants in the burn pans. The contamination found at SWMU 1d is not present below the top 1 to 2 feet in the test pits. The samples collected from the 100-foot soil boring did not contain concentrations of organics, explosives, or metals thought to be above background conditions, also indicating that the contamination present on the surface does not persist to depth. Even though the groundwater underlying SWMU 1d was not sampled, the depth to the water table here makes it unlikely that groundwater contamination has occurred due to activities at the Propellant Burn Pans. The generally fine-grained and alkaline nature of the site soils, combined with the semi-arid climate, tend to limit the movement of metals and explosive compounds.

8.3.2.2. While the nature and vertical extent of contamination has been defined at SWMU 1d, the horizontal extent of the metals and explosives contaminants cannot be defined until further sampling occurs upon facility closure.



Source: Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.

Note: All results in mg/kg.

EXPLANATION

- Test pit location
- Explosive reactivity sample location
- Deep soil boring location
- Location of burn pad (Sept.1994) —not to scale
- Proposed SWMU boundary
- Excavation pit sampled for VOCs/SVOCs
- Access roadway
- 5050 Elevation contour line
- * Data considered estimated. Refer to Appendix E.

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TEAD-N RFI—GROUP A SWMUs
OPEN BURNING/OPEN DETONATION AREA

PROPELLANT BURN PANS— SWMU 1d ANALYTICAL RESULTS FOR SURFACE AND SUBSURFACE SOILS

FIGURE 8-2

PROJECT NO. 2942.0190

8.3.3. Selection of COPCs and COPECs

8.3.3.1. Identification of COPCs. The selection of the COPCs for the Propellant Burn Pans (SWMU 1d) was based on the screening procedures outlined in Section 3.2.6. A summary of all chemicals detected in soil samples from SWMU 1d, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationale for the analytes not selected as COPCs are shown in Table 8-1.

8.3.3.2. Chemicals of potential concern selected for the human health risk assessment at SWMU 1d include the metals barium, cadmium, lead, mercury, and thallium, and the explosives 2,4-DNT and RDX. The selection of COPCs was in accordance with the methodology outlined in Section 3.2.6.

8.3.3.3. Identification of COPECs. The COPECs were selected based on the criteria outlined in the methodology discussion (Section 3.2.7.). The COPECs that are evaluated in Tier 2 and the reason for the exclusion of analytes from further evaluation are presented in Table 8-1. The inorganic COPECs consist of barium, cadmium, lead, and thallium. The only organic COPEC selected was the explosive compound 2,4-DNT.

8.3.4. Contaminant Fate and Transport

8.3.4.1. As discussed in the preceding section, the contaminants of concern at SWMU 1d include metals, and explosives (Table 8-1). Table 3-4 in the methodology section briefly describes the fate and transport characteristics for all potential contaminants of concern identified in this RFI. The remainder of this section presents a conceptual model of contaminant fate and transport for specific contaminants at SWMU 1d and discusses the fate and transport of the contaminants of concern .

8.3.4.2. Conceptual Model. A conceptual site model of contaminant transport (Figure 8-3) has been developed based on the physical site characteristics presented in Section 2.0 and the contamination assessment presented above. This model displays the potential routes of migration of contaminants from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear to be unlikely based on available data. Low levels of contamination have been released from propellant burn emissions to the surface soils from open burning. The surface soils and shallow

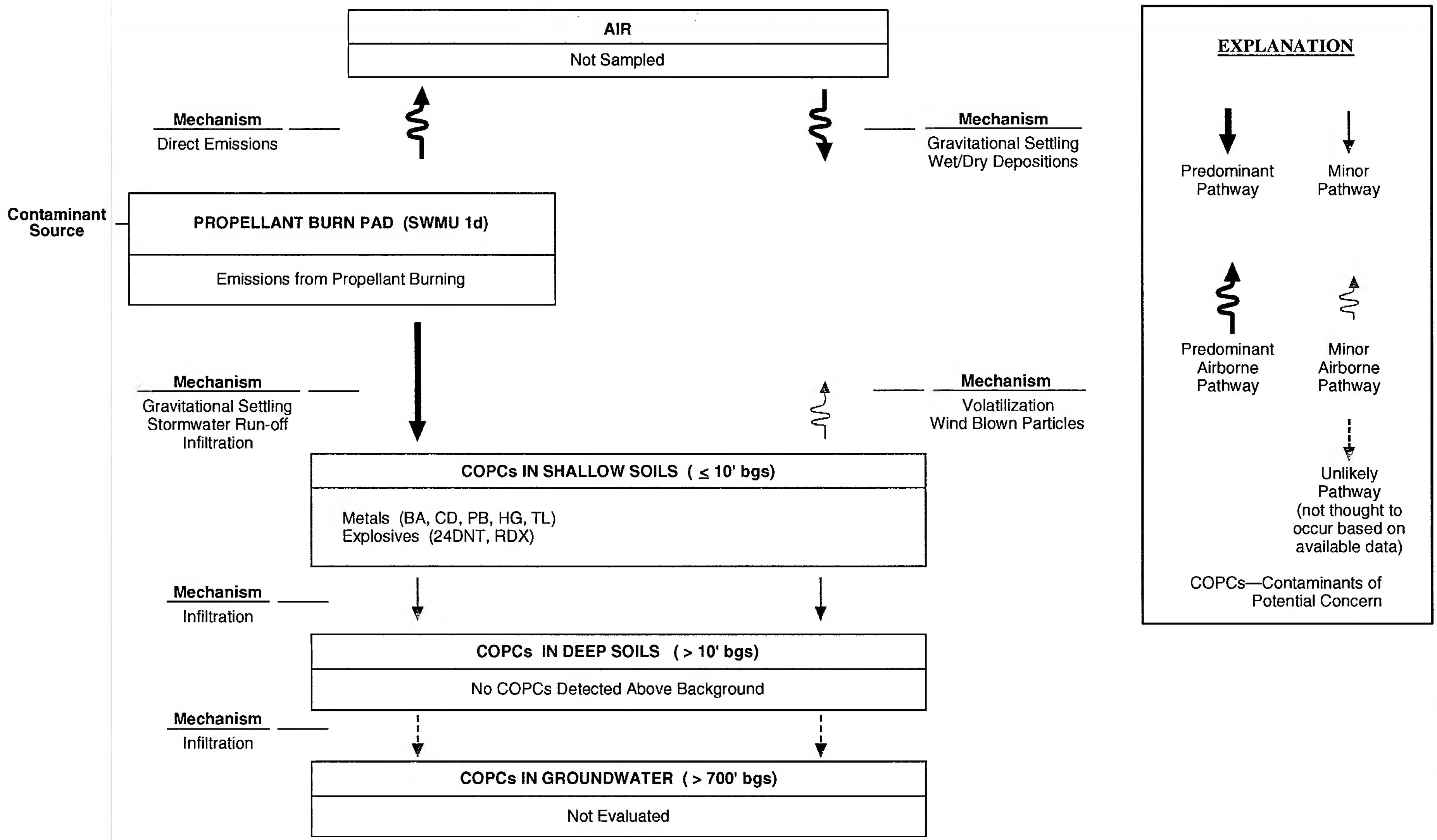
TABLE 8-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN FOR ANALYTES DETECTED IN SOIL AT SWMU 1d–PROPELLANT BURN PANS

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluate in Risk Assessment? Human	Evaluate in Risk Assessment? Ecological
Aluminum	1.62E+04	100	No(a)	No(a)
Arsenic	1.04E+01	100	No(a)	No(a)
Barium	**3.51E+02**	**100**	**Yes**	**Yes**
Beryllium	1.88E+00	94	No(a)	No(a)
Cadmium	**1.71E+00**	**38**	**Yes**	**Yes**
Chromium	2.30E+01	100	No(a)	No(a)
Cobalt	8.93E+00	100	No(a)	No(a)
Copper	2.49E+02	100	No(b)	No(e)
Cyanide	1.41E+00	25	No(c)	No(e)
Lead	**2.03E+03**	**100**	**Yes**	**Yes**
Manganese	6.07E+02	100	No(a)	No(a)
Mercury	**1.21E-01**	**38**	**Yes**	No(e)
Nickel	2.64E+01	100	No(c)	No(a)
Selenium	1.38E+00	13	No(c)	No(e)
Thallium	**1.62E+01**	**19**	**Yes**	**Yes**
Vanadium	3.15E+01	100	No(a)	No(a)
Zinc	1.49E+02	100	No(b)	No(e)
2,4-Dinitrotoluene	**1.73E+01**	**38**	**Yes**	**Yes**
Cyclonite (RDX)	**1.09E+00**	**13**	**Yes**	No(e)

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium
Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

(a) Analyte was detected at or below background concentrations
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte contributed less than 1 percent in a concentration - toxicity screen
(d) Low toxicity metal with inadequate toxicity data
(e) Maximum concentration is less than NOAEL or estimate of NOAEL



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TEAD-N RFI—GROUP A SWMUs
PROPELLANT BURN PAD (SWMU 1d)
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 8-3

soils at SWMU 1d consist of sand, silty sand, and clay; groundwater is greater than 700 feet bgs. Surface runoff is toward the east-northeast to Box Elder Wash, which is adjacent to the Propellant Burn Pans.

8.3.4.3. Fate and Transport of Metals. Transport of elevated concentrations of metals from the surface soils through the deeper soil horizons to groundwater is not expected based on the relatively low metals concentrations in the soil, the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow soils, neutral to slightly basic pH soils, and a groundwater depth of more than 700 feet below the ground surface. The deep soil boring drilled to 100 feet bgs at SWMU 1d indicated that elevated metals concentrations have not migrated below 10 feet bgs. Off-site migration of metal contaminants via a surface water pathway appears to be minimal, since soil samples collected from Box Elder Wash, down gradient of the Burn Pans, indicated no elevated metal concentrations were present. The metal contaminants at the surface may, however, provide particulates to the air pathway.

8.3.4.4. Fate and Transport of Explosives. Explosives were identified in low concentrations at SWMU 1d ($\leq$ 13.6 mg/kg). Even though these compounds tend to be mobile in the environment, the potential for leaching of explosives to deep soils (> 10 feet bgs) or groundwater is unlikely based on the large depth to groundwater, low precipitation rates, and high evaporation rates. Attenuation of explosives in the surface and shallow subsurface could be expected through slow volatilization to the atmosphere and/or by slow photolytic transformations, and in the subsurface through very slow biodegradation processes.

8.4 HUMAN HEALTH RISK ASSESSMENT

8.4.0.1. The methods used to estimate the risks associated with SWMU 1d are given in Human Health Risk Assessment Methodology, Section 3.2.6. The COPCs were identified in the previous section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 1d) is presented in the following sections.

8.4.1. Exposure Pathways and Receptors

8.4.1.1. The pathways quantitatively evaluated in the BRA are: 1) those that are complete or likely to be completed in the future, and 2) those that may cause a significant risk. A conceptual model for exposure pathways at SWMU 1d is shown on Figure 8-4.

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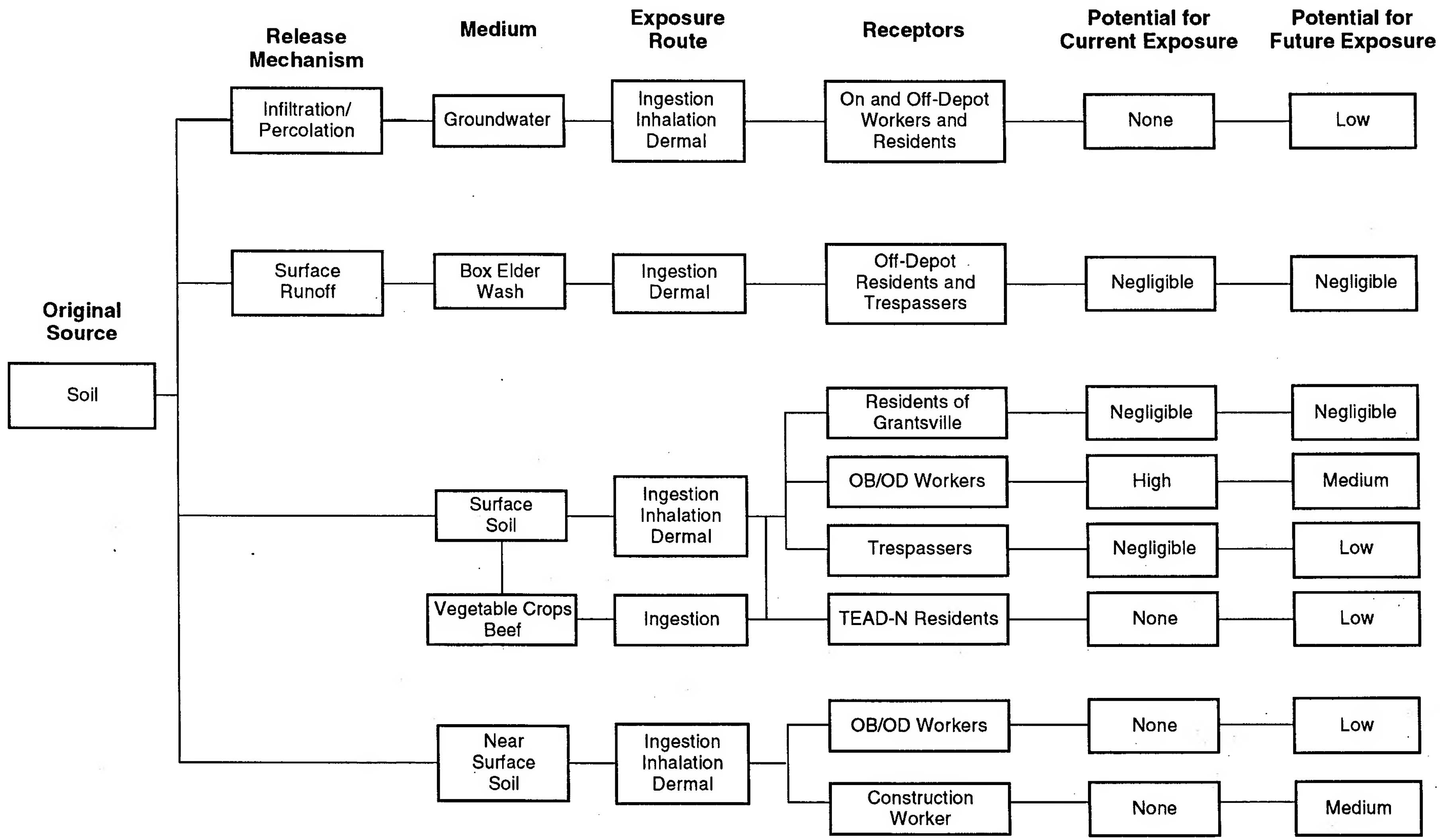


MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
PROPELLANT BURN PANS—SWMU 1d
EXPOSURE PATHWAYS DIAGRAM
FIGURE 8-4

An evaluation of pathway completeness and an assessment of whether a pathway is significant enough to require further evaluation for current and potential future receptors at SWMU 1d is given in Tables 8-2 and 8-3, respectively. Note that potential exposure pathways included in this BRA are limited to exposures to chemicals which have been released to the environment. This assessment does not address occupational exposure during propellant burn operations.

8.4.1.2. The current on-Depot receptors are the civilian Depot personnel who conduct open burns at SWMU 1d. Typically, one surveillance person and four to five workers load propellant in up to fifteen pans, where it is subsequently burned. When operating at capacity, one burn is conducted in the morning and another in the afternoon for a maximum of seven months per year. The activities of personnel conducting the burns are not invasive and the workers are generally not in direct contact with the soil. Even though the personnel do not have direct contact with soil, they may have incidental ingestion, dermal, and inhalation exposure, primarily via dust. The exposure estimates for the Propellant Burn Pans assume the burning operations are operating at full capacity, i.e., the exposure frequency and time are reasonable maximums.

8.4.1.3. Potential future on-Depot receptors for contaminants originating from SWMU 1d include construction workers. As shown in the exposure pathway diagram (Figure 8-4), construction workers can be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For future construction workers, direct exposure results from the anticipated excavation activities associated with construction and includes subsurface soil as well as surface soil. Should this portion of the Depot be closed in the future (it is not slated for closure at this time), residents could also become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. It should be noted that a residential development is unlikely even if the Depot is closed since SWMU 1d is in a remote area. However, because of the requirements of UAC 315-101 (1994), a residential scenario was evaluated.

8.4.1.4. SWMU 1d could be converted into an area where crops are grown. However, efforts to grow vegetables in soil from adjacent areas failed (Rust E&I, 1995). The experiments included soil from an area where there was no known release of hazardous chemicals. It was concluded that the salt content of the soil was "toxic", and that vegetables could not be grown without leaching salt from the soil. Although such activities are considered unlikely, this pathway is evaluated as part of the future residential scenario.

TABLE 8-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 1d: PROPELLANT BURN PANS

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is about 700 feet below ground surface. Soil samples from 10 feet to the maximum depth explored of 100 feet below ground surface were not contaminated.
Surface Water and Sediment			
Box Elder Wash	Trespasser and off-Depot residents.	Incidental ingestion and dermal contact with water or sediment	No. Only rarely is there water in the wash. Samples collected from the wash were not contaminated.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust and emissions from the open burning/detonation operations	No. SWMU 1d is small and the amount of dust in Grantsville originating from SWMU 1d will be minuscule.
	OB/OD workers	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil is contaminated. Vegetative cover is sparse and fugitive dust is likely. Workers routinely pick up metal debris in this area.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. No evidence of trespassers, i.e. no tracks or sightings.
Near-Surface Soil	OB/OD workers	Incidental ingestion of dust, inhalation, and dermal contact	No. OB/OD worker activities do not include invasive activities such as excavations.
Air	OB/OD workers	Inhalation of volatile organics from subsurface soil	No. Volatile organics were not detected. Dust exposure evaluated under soil.

OB/OD Open Burning/Open Detonation

TABLE 8-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 1d: PROPELLANT BURN PANS

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely to result in the future. Groundwater is over 700 feet below the below ground surface and evapotranspiration is high.
Surface Water and Sediment			
Box Elder Wash	Future TEAD-N residents	Incidental ingestion, dermal contact with water or sediment	No. Only rarely is there water in the wash. Sediment samples collected from the wash were not contaminated.
	Trespassers	Incidental ingestion, dermal contact with water or sediment	No. Only rarely is there water in the wash. Sediment samples collected from the wash were not contaminated.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 1d is small and the amount of dust in Grantsville originating from SWMU 1d will be minuscule.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Although a future residential scenario is unlikely because the Depot does not anticipate closing this area, this pathway will be evaluated, as required by State of Utah regulations.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	OB/OD workers	Incidental ingestion of dust, inhalation, and dermal contact	No. Exposure will be the same as that evaluated under current conditions.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers are not anticipated and exposures will be less than those evaluated under the residential scenario.
Near-Surface Soil	Construction worker	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Although future scenarios involving construction are unlikely, they cannot be ruled out.
Air	OB/OD workers	Inhalation of volatile organics from subsurface soil	No. Volatile organics were not detected. Dust exposure evaluated under soil.

OB/OD Open Burning/Open Detonation
TEAD-N Tooele Army Depot North Area

8.4.1.5. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. This pathway is also evaluated as part of the future residential scenario.

8.4.1.6. For the pathways that were evaluated quantitatively (see Tables 8-2 and 8-3), site-specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are given in Appendix K.

8.4.2. Risk Characterization

8.4.2.1. Human health risks are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 1d. The methods for calculating the risks are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

8.4.2.2. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable (unless there are reasons to believe the risks have been underestimated), a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these valves may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects are possible. Adult blood lead levels between 10 and 15 micrograms per deciliter (µg/dl) constitute a benchmark range based on hypertension in adult males and transfer of lead from a pregnant mother to her fetus. For children, 10 µg/dl is the benchmark typically used by the EPA (USEPA, 1994).

8.4.2.3. In addition to the calculated risk estimates, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for current Depot personnel, potential future construction workers, and potential future residents.

8.4.2.4. OB/OD Workers. The current OB/OD workers were assumed to be exposed to COPCs in the soil from a depth of 0 to 0.5 feet. As shown in Table 8-4, the calculated excess lifetime cancer risk for current OB/OD workers is 4×10^{-7}, which is below the benchmark of 1×10^{-6}. The total hazard index for OB/OD workers was estimated to equal 0.4, which is below the benchmark of 1. The concentration of lead in blood was estimated to be 5.0 µg/dl, which is below the benchmark range of 10 to 15 µg/dl. These risks are all insignificant unless there is a potential for underestimating the actual risks. The greatest potential for underestimating risks is in the hazard index, where the inhalation exposure pathway has not been fully accounted for due to the absence of inhalation reference doses for most of the COPCs. However, the exposure doses are in a range where adverse health effects are unlikely (see Appendix K for the exposure doses). A summary of the risk estimates and qualitative factors affecting these estimates is presented in Table 8-5.

8.4.2.5. Potential Future Construction Worker. Potential future construction workers were assumed to be exposed to COPCs in the soil from a depth of 0 to 12 feet during excavation activities. As shown in Table 8-6, the calculated excess lifetime cancer risk is 1×10^{-8}. The total hazard index for potential future construction workers was estimated to equal 0.07, and the concentration of lead in blood was estimated to be 4.5 µg/dl. Like the OB/OD worker, these risks are considered insignificant. Also, like the current OB/OD worker, the inhalation exposure pathway has not been fully accounted for due to the absence of inhalation reference doses for most of the COPCs, but the exposure doses are in a range where adverse health effects are unlikely (see Appendix K for the exposure doses).

8.4.2.6. Potential Future TEAD-N Resident. Potential future residents at SWMU 1d were assumed to be exposed to COPCs in the soil from a depth of 0 to 0.5 feet. The cancer risk from all exposure pathways was estimated to equal 5×10^{-2} and the hazard index was estimated to equal 200. As shown in Table 8-7, the excess lifetime cancer risk for potential future residents exposed to soil at SWMU 1d was estimated to be 1×10^{-5}, and the hazard index was estimated to equal 2. The blood-lead concentration in children was estimated to be 13.2 µg/dl. The cancer risk from exposure to soil is in a range generally considered to be insignificant. The hazard index from exposure to soil is at a level where health effects may be possible, and primarily results from the ingestion of thallium. Due to the likely overestimate in the ingestion rate (see Section 8.4.3), the use of an exposure point concentration over half the maximum when detected in less than 20 percent of the samples, and the fact that thallium's reference dose of 0.00008 mg/kg/day has an uncertainty of 3,000 (indicating that the toxicity of thallium is not well defined as

TABLE 8-4

SWMU 1d - PROPELLANT BURN PANS
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR OB/OD WORKERS

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	1.58E+00	NC	NC	3E-07	3E-07	84
Cyclonite (RDX)	6.99E-01	7E-09	6E-08	NC	6E-08	16
Pathway Total		7E-09	6E-08	3E-07		
Percent of Total		2	14	84		
				Total Cancer Risk:	**4E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Barium	3.23E+02	1E-03	2E-03	3E-01	3E-01	89
Cadmium	1.58E+00	4E-04	5E-04	NC	9E-04	<1
Lead	1.27E+03	NA	NA	NA	NA	NA
Mercury	9.10E-02	7E-05	4E-05	1E-04	2E-04	<1
Thallium	9.79E+00	3E-02	3E-03	NC	3E-02	9
2,4-Dinitrotoluene	1.16E+01	1E-03	5E-03	NC	6E-03	2
Cyclonite (RDX)	6.99E-01	6E-05	5E-04	NC	5E-04	<1
Pathway Total		3E-02	1E-02	3E-01		
Percent of Total		9	3	88		
				Total Hazard Index:	**4E-01**	
				Blood Lead Concentration µg/dl (95th percentile):	**5.0**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 8-5

TEAD-N BASELINE RISK ASSESSMENT
SWMU 1d–PROPELLANT BURN PANS PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (µg/dl)	Key Chemicals[a]
OB/OD Workers					5.0	
Ingestion	Current likely	Medium/High	0.03	7×10^{-9}		Barium, cadmium, cyclonite
Dermal	Current likely	High/Neutral-High	0.01	6×10^{-8}		
Inhalation	Current likely	High/High	0.3	3×10^{-7}		
Construction Workers					4.5	
Ingestion	Future moderate	Medium/High	0.04	2×10^{-9}		Barium, cadmium, thallium, cyclonite, 2,4-dinitrotoluene
Dermal	Future moderate	High/Neutral-High	0.005	2×10^{-9}		
Inhalation	Future moderate	High/High	0.02	9×10^{-9}		
TEAD-N Residents					13.2	
Ingestion	Future unlikely	Medium/High	2	1×10^{-7}		2,4-Dinitrotoluene Cyclonite (RDX)
Dermal	Future unlikely	High/High	0.02	2×10^{-7}		
Inhalation	Future unlikely	High/High	0.1	5×10^{-8}		
Vegetable Crops	Future unlikely	High/High	200	5×10^{-2}		
Beef	Future unlikely	High/Neutral	0.0009	1×10^{-11}		

TEAD-N Tooele Army Depot North Area

(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

TABLE 8-6

SWMU 1d - PROPELLANT BURN PANS
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	9.85E-01	NC	NC	9E-09	9E-09	73
Cyclonite (RDX)	4.65E-01	2E-09	2E-09	NC	3E-09	27
Pathway Total		2E-09	2E-09	9E-09		
Percent of Total		14	13	73		
				Total Cancer Risk:	**1E-08**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Barium	2.39E+02	8E-03	1E-03	2E-02	3E-02	49
Cadmium	9.85E-01	2E-03	3E-04	NC	3E-03	4
Lead	5.80E+02	NA	NA	NA	NA	NA
Mercury	6.30E-02	5E-04	3E-05	7E-05	6E-04	<1
Thallium	7.30E+00	2E-02	2E-04	NC	2E-02	32
2,4-Dinitrotoluene	5.51E+00	6E-03	2E-03	NC	9E-03	13
Cyclonite (RDX)	4.65E-01	4E-04	3E-04	NC	7E-04	<1
Pathway Total		4E-02	5E-03	2E-02		
Percent of Total		58	7	35		
				Total Hazard Index:	**7E-02**	
		Blood Lead Concentration µg/dl (95th percentile):			**4.5**	

CR	Cancer risk
HI	Hazard index
NA	Not applicable
NC	Not calculated
RME	Reasonable maximum exposure

TABLE 8-7

SWMU 1d - PROPELLANT BURN PANS
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	1.58E+00	NC	NC	5E-08	NC	NC	5E-08	<1
2,4-Dinitrotoluene	1.16E+01	1E-05	2E-07	NC	5E-02	1E-11	5E-02	96
Cyclonite (RDX)	6.99E-01	1E-07	2E-07	NC	2E-03	4E-14	2E-03	4
Pathway Total		1E-05	4E-07	5E-08	5E-02	1E-11		
Percent of Total		<1	<1	<1	100	<1		
					Total Cancer Risk:		**5E-02**	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Barium	3.23E+02	6E-02	8E-03	1E-01	3E-01	2E-07	4E-01	<1
Cadmium	1.58E+00	2E-02	2E-03	NC	4E-01	1E-07	4E-01	<1
Lead	1.27E+03	NC	NC	NC	NC	NC	NC	NC
Mercury	9.10E-02	4E-03	2E-04	3E-05	1E-02	2E-08	2E-02	<1
Thallium	9.79E+00	2E+00	1E-02	NC	2E-01	9E-04	2E+00	<1
2,4-Dinitritoluene	1.16E+01	7E-02	7E-04	NC	2E+02	6E-08	2E+02	84
Cyclonite (RDX)	6.99E-01	3E-03	2E-03	NC	3E+01	8E-10	3E+01	15
Pathway Total		2E+00	2E-02	1E-01	2E+02	9E-04		
Percent of Total		<1	<1	<1	99	<1		
					Total Hazard Index:		**2E+02**	
			Blood Lead Concentration µg/dl (95th percentile):				**13.2**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure
TEAD-N Tooele Army Depot North Area

opposed to indicating that it is highly toxic), no health effects are expected from exposure to soil. The blood lead concentration is in a range where health effects may be observed in children. The model used for estimating blood lead concentrations uses expected (rather than reasonable maximum) exposure parameters, and consequently the result is not considered significantly conservative. The significance of the residential risk estimates are diminished because the potential for pathway completeness is low.

8.4.2.7. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 1d, the estimated cancer risk is 5×10^{-2} and the hazard index is 200 (Table 8-7), primarily due to the explosives 2,4-DNT and RDX. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has several orders of magnitude of uncertainty because of uncertainties in the plant uptake factors (see Section 8.4.3.). If plants metabolize explosives (which is not accounted for in the uptake model), the risks from explosives via this pathway would be low. Because of the high degree of uncertainty, the significance of these risk estimates is unknown.

8.4.2.8. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 1d, the estimated cancer risk is 1×10^{-11} and the hazard index is 0.0009 (Table 8-7). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 1d if they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

8.4.3. Uncertainties

8.4.3.1. The exposure estimates and toxicity values have associated uncertainties. The magnitude and nature of these uncertainties affects the confidence in the results. Most of the uncertainties are such that risk estimates could be lower than estimated, but are unlikely to be higher. The following paragraphs discuss the uncertainties related to

exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor, which focus on elements contributing most to overestimates of the total risk, and on those elements where risks may be underestimated. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk at SWMU 1d.

8.4.3.2. The exposure point concentrations (concentrations of chemicals in an environmental medium at the point where a receptor is exposed) used in the risk calculations were based in part on judgmental sampling, i.e., samples were collected from in or immediately below stained soil or debris, where observed. Because areas of burning occupy only a portion of this SWMU and because soil beneath stained areas would tend to be more contaminated than typical soil from this area, the exposure point concentrations are representative of the most contaminated areas, rather than the SWMU as a whole.

8.4.3.3. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

8.4.3.4. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical (tetraethyl lead) with a reference dose below 1×10^{-6} mg/kg/day , and this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation of metals with exposure doses greater than

1×10^{-6} was examined on a case-by-case basis. The results of this evaluation were presented in Section 8.4.2. Exposure doses are summarized in Appendix K.

8.4.3.5. OB/OD Workers. Uncertainties for OB/OD personnel generally overestimate potential risks. These overestimates are related to factors such as the exposure duration, the concentration of contaminated dust, and the ingestion rate. Because no significant risks were calculated and because the uncertainties tend to result in an overestimate of risks, the specific uncertainties do not require detailed discussion. One factor which may tend to underestimate risk is the dermal absorption factor of organic compounds (as opposed to metals; dermal absorption of metals is thought to be small [USEPA, 1992]). However, RDX would need to be absorbed 5 times as efficiently as was estimated to cause a cancer risk of 1×10^{-6}. This is without considering any factors that would tend to overestimate potential risks, such as the exposure duration, the exposure point concentration, and the area of exposed skin covered by contaminated soil. Therefore, a cancer risk greater than 1×10^{-6} is unlikely. Even with 100 percent absorption the total hazard index would be less than 1.

8.4.3.6. Construction Worker. Uncertainties associated with the exposure dose for a construction worker are generally similar to the OB/OD worker, as the exposure assumptions were generally the same. One exception is the exposure duration of one year for the construction worker, which is more common than the 25 years assumed for a OB/OD worker. Also, because excavation activities may generate more dust than intrusive activities by a Depot worker, the inhalation risk may be less of an overestimate (but it is still not expected to be an underestimate). Dermal risks are low enough such that significant risk levels would not be exceeded even if COPCs were 100 percent absorbed.

8.4.3.7. TEAD-N Residents. The uncertainties for construction and OB/OD workers are also uncertainties in the evaluation of potential future TEAD-N residents, although the magnitude of the uncertainties differs. In a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure and, to a lesser extent, reduces the potential for dermal and ingestion exposure. The hazard index of 2 results from the presence of thallium. It would not be unreasonable for the estimate of the exposure point concentration (EPC) to be higher than the true average by more than a factor of 2. This is because the EPC is over half the maximum concentration even though thallium was detected in only one out of every five samples, thus indicating that the EPC is heavily influenced by a small minority of

samples. As in the case of the workers, uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the dust level, and dermal uncertainties are derived from the skin surface area covered with contaminated dust and the fraction of chemicals absorbed. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who directly eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate exceeds the assumed rate of 200 mg/day. The exposure parameters for estimating blood lead concentrations often have similar levels of uncertainty as when calculating cancer risks and hazard indices, but several parameters (such as the soil ingestion rate) are central tendency estimates rather than estimates associated with a reasonable maximum exposure (note that some parameters, such as the dust level in air, are not central tendency values). Consequently, the blood lead concentration is less likely to be an overestimate than the hazard index or cancer risk.

8.4.3.8. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

8.4.3.9. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53.

8.4.3.10. There is even greater uncertainty at SWMU 1d. The estimated risks for the produce exposure pathway are dominated by 2,4-DNT and RDX. However, the equation used to estimate the plant uptake factors from the log K_{ow} was developed using mostly data for pesticides, which are very different from explosives; a poorer fit would be expected for explosives than for compounds used to develop the relationship. The plant uptake model also does not account for metabolism of the chemical by the plant. Based on their polar structure, it would not be surprising if plants metabolize 2,4-DNT and

RDX, thus eliminating exposure to explosives by humans through this pathway. In addition, because the salt content of the soil is currently toxic to plants (see Section 8.4.1.4.), the soil would need to be diluted with peat or other soil amendments to grow produce. This has not been accounted for in the exposure calculations. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

8.4.4. Recommendations

8.4.4.1. Based on the preceding discussions, the following recommendations are made with respect to potential human health risks:

- Allow unrestricted use of this site as long as it remains part of the depot

- Re-evaluate contamination and potential risks upon facility closure.

Note that the recommendation for unrestricted land use is made solely with respect to human health risks from chemical toxicity. Restrictions are recommended based on the potential for explosive risks, as discussed in Sections 8.6 and 5.6.

8.5 ECOLOGICAL RISK ASSESSMENT

8.5.0.1. This section discusses the results of the Tier 1 and Tier 2 ecological evaluations. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4.

8.5.1. Tier 1

8.5.1.1. Ecological Receptors. SWMU 1d is a disturbed area, and is completely bare in spots. Large windrows of Russian thistle have accumulated near the pans. Common weedy species here include Russian thistle, gumweed, annual sunflower, storksbill and flixweed. Native species around the disturbed area include sand dropseed, red three-awn, Indian ricegrass, a patchy distribution of needle-and-thread grass, Basin big sagebrush, and black greasewood. The mapped range and soil types are:

Range Site: Loamy Bottom

Soil Types: Hiko Peak Gravelly Loam and Birdow Loam

8.5.1.2. Expected Climax Vegetation. The range site describes the climax vegetation expected to occur at each site due to the combined influence of environmental factors characteristic for the site. SWMU 1d occurs in the loamy bottom range site. Characteristic vegetation expected in the loamy bottom range site includes basin big sagebrush, rubber rabbitbrush, basin wildrye and western wheatgrass (USSCS, 1991).

8.5.1.3. Wildlife. No reptiles were observed at SWMU 1d but, based on siting elsewhere at the Depot, the collared and side-blotched lizard, the western whiptail, the Great Basin rattlesnake, and the gopher snake may potentially be inhabitants at or near SWMU 1d.

8.5.1.4. Although no small mammals were observed at SWMU 1d, rabbit pellets from black-tailed jackrabbits and the cottontail rabbits were observed, as well as valley pocket gopher mounds. Based on observations elsewhere at the Depot and the type of habitat, the common small mammal species that could be inhabitants at SWMU 1d include the Ord's kangaroo rat, the deer mouse, the Great Basin pocket mouse, pinyon mouse, sagebrush vole, the desert woodrat, and the little pocket mouse (Burt and Grossenheider, 1980; RUST, 1994). There is no evidence from the field surveys that large mammals are present at SWMU 1d. However, large mammals such as the coyote (personal communication, Dr. J. Merino), mule deer, and pronghorn antelope may occur at SWMU 1d on an intermittent basis.

8.5.1.5. Raptors such as the golden eagle, American kestrel, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, red-tailed hawk, and the great-horned owl have been observed in other areas of TEAD-N but not at SWMU 1d. Because of the typical range of these species during foraging/hunting activities, raptors may be at SWMU 1d on an intermittent basis.

8.5.1.6. No passerine or other birds were observed during the site visit. The sage grouse, a State of Utah sensitive species, may inhabit the undisturbed areas near the SWMU. Other potential non-game birds such as crows and several families of passerine birds would not be unexpected.

8.5.1.7. Results of the Tier 1 Ecological Assessment. The field surveys indicated that the vegetation at SWMU 1d has been impacted to a greater degree by the physical activities at the site, i.e., burning and clearing activities, than by the chemicals that may have been released at the site. The ecological assessment, therefore, addresses the potential adverse impact to the wildlife receptors and it is not deemed necessary to address the ecological effects on the vegetation. The ecological assessment is performed with the assumption that the wildlife receptors are not limited by the physical boundaries of each SWMU, i.e., the spatial distribution of the detected chemicals at SWMU 1d is assumed to potentially expose the wildlife species that occur or that may potentially occur at the TEAD-N facility as a whole. The results of the Tier 1 assessment indicate that the levels of some of the chemicals detected at SWMU 1d warrant a Tier 2 evaluation.

8.5.2. Tier 2

8.5.2.1. The objective of the Tier 2 assessment is to further evaluate the Tier 1 COPECs by comparing the receptor's chemical exposure dose to a biological endpoint.

8.5.2.2. Exposure Analysis. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil. Indirect exposure occurs via the food web, such as when a raptor consumes the mouse. SWMU 1d has no surface water present, therefore, the surface water exposure pathway is incomplete and is not included in the ecological assessment.

8.5.2.3. The reptiles potentially inhabiting SWMU 1d may be exposed via direct pathways (ingestion and dermal exposure to soil) and, to a lesser extent, via food web pathways (e.g. ingestion of contaminated insects). As prey, they may also expose predators.

8.5.2.4. The small mammals are predominantly exposed via direct pathways (ingestion of soil) and, to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators.

8.5.2.5. The antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing) and as prey, may expose predators. Coyotes (a predator) are exposed predominantly via food web pathways unless their den is located in contaminated soil. This would cause a significant direct exposure by ingestion of soil.

8.5.2.6. The predominant route of exposure for the raptors is via food web pathways because they typically do not spend much time on the ground. The non-raptor birds are exposed via food web pathways by ingestion of seeds and grasses, and by direct exposure to soil during preening.

8.5.2.7. Risk Characterization. The ecological risk characterization for the COPECs at SWMU 1d is based on the ecological toxicity quotient derived by comparing either the dose ingested by the indicator species or the chemical concentration in the soil, to a biological endpoint. The ingestion pathway is associated with the greatest exposure at TEAD-N. The results indicate that barium, lead, and thallium are the COPECs at SWMU 1d that have ETQs greater than 1.0. The results of the ecological evaluation are presented in Appendix K.

8.5.2.8. The estimated ETQs are overestimations due to the uncertainties in the evaluation. The calculations were done with the assumption that the foraging area of the receptors is exclusively within the contaminated area at SWMU 1d. This conservative assumption leads to a contaminant intake or dose that is significantly higher than what is actually being ingested by the receptors. When the foraging area exceeds the contaminated area, a correction factor that accounts for less than full-time exposure is required (deSesso, 1994). The mobility factor is a suggested method for estimating the fraction of time that a receptor may be exposed to a contaminant. The mobility factor is the ratio of the contaminated area to the foraging area and accounts for the effect of receptor mobility to the frequency and duration of exposure to the contaminated media. The areal extent of SWMU 1d is very small relative to the foraging area of the selected indicator species, significantly reducing the ETQs. Consequently, the potential for adverse impacts to the ecological receptors is diminished. The receptors that may have a high exposure are the less mobile receptors such as the reptile or small mammals species. The field surveys did not observe these species at SWMU 1d, but the ecological assessment identifies them as potentially occurring at the site. The impact to less mobile terrestrial receptors at SWMU 1d is not significant enough to adversely affect the structure and function of the ecosystem due to the limited number of individuals potentially affected based on the size of the SWMU. It is, therefore, recommended that SWMU 1d be proposed for no further investigation into the potential for ecological effects.

8.5.2.9. Uncertainties. The ecological evaluation does not take into account the frequency of exposure to the contaminant nor the effect of receptor mobility on the frequency and duration of contact with the contaminated media. The use of NOEL-type values as surrogates for effective concentrations has a significantly more conservative meaning as an indicator of risk. The use of NOAEL-type values assumes 100 percent bioavailability of the contaminants. For soil, 100 percent bioavailability is likely an overestimate for most contaminants.

8.5.3. Recommendations

8.5.3.1. Based on the preceding discussions, SWMU 1d is recommended for no further investigation regarding potential ecological effects.

8.6 DETERMINATION OF EXPLOSIVE RISK

8.6.0.1. Because the Propellant Burn Pans are contained in the same area as the Main Demolition Area (SWMU 1), no separate determination of explosive risk was performed. The reader is referred to Section 5.6. for the discussion of explosive risk at the Main Demolition Area.

9.0 AED DEACTIVATION FURNACE SITE (SWMU 20)

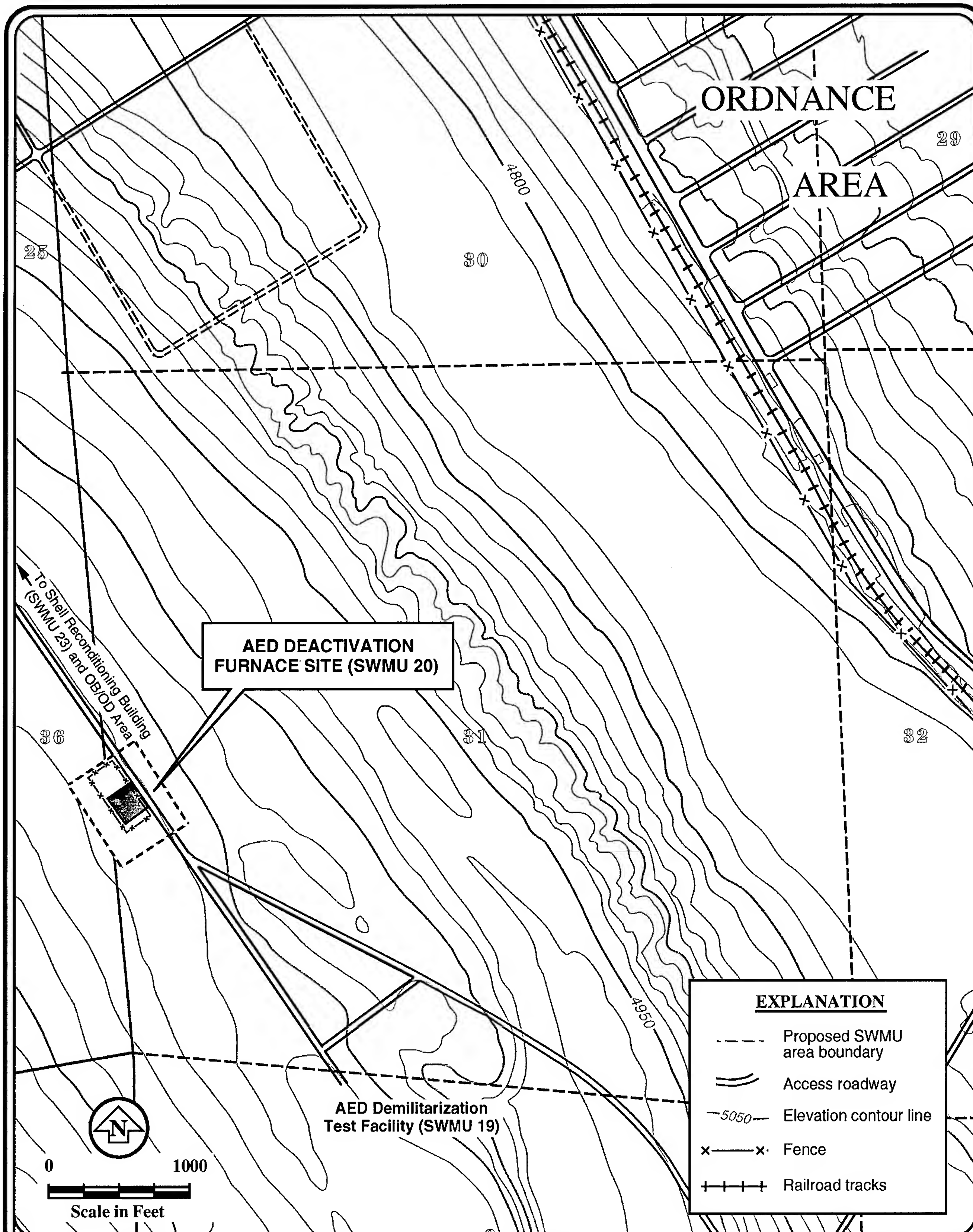
9.1 SITE BACKGROUND

9.1.0.1. Site Description. The AED Deactivation Furnace Site is located approximately one mile southwest of the Ordnance Area, along the road that links the AED Demilitarization Test Facility (SWMU 19) and the Bomb and Shell Reconditioning Building (SWMU 23) (Figure 9-1). This facility is used to test demilitarization procedures for various munitions; it is not used as a production facility (Rhea, 1990). The facility has been active since about 1970 and is composed of two furnaces, a large air pollution control system, and a small storage building. The entire facility sits on an asphalt pad approximately 200 feet by 225 feet in size which is underlain by compacted gravel fill. A small area of the western corner of the asphalt surface was once used to store drummed residue, and is referred to as the former Hazardous Waste Holding Area.

9.1.0.2. One underground storage tank containing heating oil, with associated underground piping, is located in the central part of the facility southeast of the main furnace. During the summer and fall of 1993, a new above ground tank and concrete pad were installed about 80 to 100 feet northwest of Building 1351. The concrete pad for this tank was designed with bermed sides to catch any release that might occur. SWMU 20 is surrounded by a four-foot high barbed wire fence, with two metal gates providing access from the adjacent graveled road.

9.1.0.3. Operational Activities. The deactivation furnace in Building 1351 is a rotary kiln type that has been used for destruction of high explosive-filled projectiles (up to 155 mm), grenades, propellants, boosters, fuses, white phosphorus rockets, and bulk explosives (EA, 1988). A flashing furnace was added to the AED Deactivation Furnace Site in 1976, and is used for burning residual material remaining in munitions shell casings after initial treatment in the deactivation furnace. During an upgrade in 1976, a shared air pollution control system was installed to treat stack emissions from both the deactivation and the flashing furnace (Rhea, 1990). The air pollution control equipment includes duct work from the two furnaces and an after burner, cyclone, gas cooler, baghouse, and wet scrubber.

9.1.0.4. The AED Deactivation Furnace Site is currently used to conduct treatability studies, and operates under interim RCRA approval through an experimental variance. This variance allows the throughput of up to 250 kilograms (550 pounds) of material per



Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 20
AED DEACTIVATION FURNACE SITE
LOCATION MAP
FIGURE 9-1

day. After deactivation, all residual metal parts are certified as clean and sent to the DRMO for salvage (EA, 1988). Baghouse dust and ash are collected in 55-gallon drums, which are sealed and sent to the 90-Day Storage Yard (SWMU 28) pending analysis and disposal.

9.1.0.5. Geology and Hydrology. Soils underlying the AED Deactivation Furnace Site are composed of sands, sandy gravels, and gravelly loams of the Hiko Peak series (USSCS, 1991), although the material immediately beneath the facility is compacted gravel fill. Surface water drainage is toward the northeast. The approximate depth of groundwater is 620 feet bgs, and the direction of groundwater flow is toward the northeast (JMM, 1988).

9.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

9.2.1. Previous Investigations

9.2.1.1. Prior to the RFI, investigations of the AED Deactivation Furnace Site were limited to analysis of samples of baghouse dust and furnace residue. Although the baghouse dust was determined not to be a reactive waste, concentrations of lead, barium, and cadmium have been detected above the thresholds for characterizing a waste as hazardous based on EP Toxicity (AEHA, 1985). EP Toxicity concentrations of cadmium (206 mg/l) were detected in baghouse dust leachate after an incineration test of 20 mm cartridges. Concentrations of lead in baghouse dust sampled after performing incineration tests of 4.62 mm and .30 caliber cartridges resulted in concentrations of 5.2 mg/l and 4.7 mg/l lead, respectively, in the EP Toxicity extract (the hazardous waste threshold for lead for this test is 5.0 mg/l). In addition to the elevated concentrations of lead and cadmium, one sample of furnace residue also contained 440 mg/kg total thallium.

9.2.2. RFI Sampling Summary

9.2.2.1. Phase I Sampling. Eleven surface soil samples were collected from around the perimeter of the facility and five samples were collected from beneath the asphalt surface of the AED Deactivation Furnace Site during Phase I activities in July 1992. These samples were composited from aliquots obtained along the edges of the asphalt-covered surface, except for the four samples collected from beneath the asphalt surface. Sample locations were sited to give general surficial coverage around the perimeter of the furnace

facility, with the objective of establishing the presence or absence of contamination from this operation.

9.2.2.2. Phase II Sampling. A total of 21 3-foot soil borings were drilled at and around SWMU 20 during Phase II investigations. Nineteen of these borings were sampled for total metals and explosives, with three soil samples collected from each boring at depths of 0-0.5 feet, 1-1.5 feet, and 2.5-3 feet bgs (57 environmental samples total). These borings were sited to investigate the vertical and horizontal migration of contamination detected during Phase I sampling. To explore whether these contaminants may have migrated to the subsurface, nine of the boreholes were drilled in or around the periphery of the asphalt covering in areas where the previous Phase I samples had detected contaminants. The remaining ten boreholes were drilled at distances up to 250 feet from SWMU 20 to investigate the possibility that contaminants from the facility may have moved horizontally due to wind or surface water runoff.

9.2.2.3. Two 3-foot borings were drilled at locations up to 800 feet from SWMU 20, and two soil samples submitted from each (four samples total) for total metals analysis. These samples were collected to provide additional information on the background concentrations of metals in the Depot soils.

9.2.2.4. Additional surface soil sampling was conducted to address data gaps identified during regulatory review of this document. Six surface soil samples were collected for hexavalent and total chromium to provide data to investigate the areal distribution of chromium contamination and to estimate the concentration of chromium that is present in the more toxic hexavalent state. Three surface soil samples were collected for dioxin/furan analysis to investigate the presence or absence of these compounds.

9.2.2.5. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that most of the SWMU 20 data are usable. One explosive, 1,3,5-trinitrotoluene, was rejected in 20 samples by the USAEC chemistry branch due to low, low spike recoveries (all the sample concentrations were below the certified reporting limit [CRL]); the data are not usable. Eight soil samples had several metals with matrix spike/matrix duplicate (MS/MSD) nonconformances which resulted in qualification by the Montgomery Watson chemists. The hexavalent chromium results for this SWMU are positively biased due to analytical method interferences and should be considered conservative. One hundred percent completeness was achieved at this SWMU for all

parameters except explosives. The explosives completeness was 100 percent with the exception of 1,3,5-trinitrotoluene which had 35 percent completeness. The overall completeness for explosives is acceptable for project needs. Further details concerning the data review are presented in Appendix E of this document.

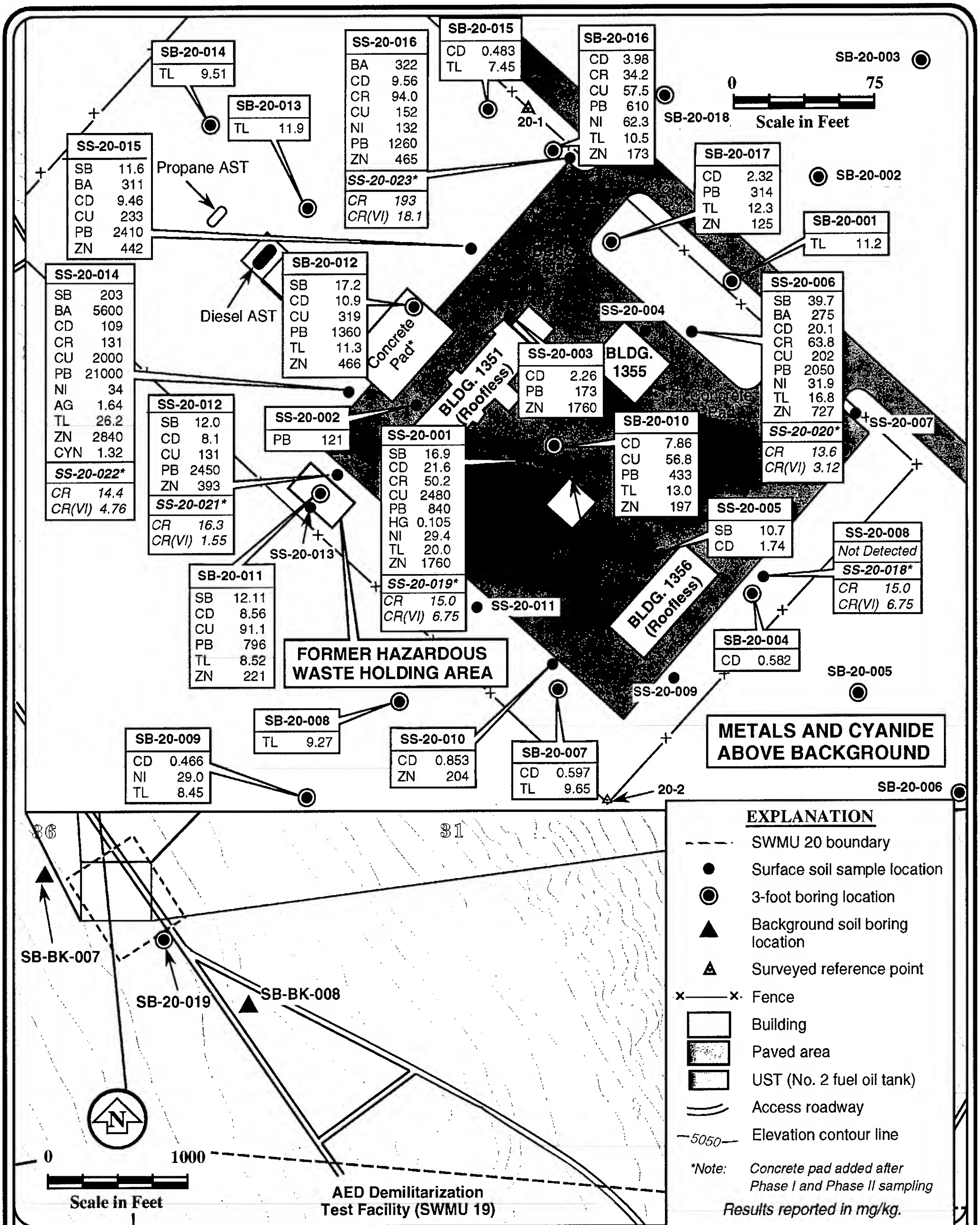
9.2.2.6. The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviations and the data quality objectives were met. Due to this, no data gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

9.3 CONTAMINANT ASSESSMENT

9.3.1. RFI Sampling Results

9.3.1.1. Chemicals detected in the soils at SWMU 20 included elevated metals and cyanide, with lesser amounts of organic compounds (VOCs and SVOCs) and explosives. Elevated levels of numerous metals were detected in the majority of the soil samples collected, both from the surface and the shallow subsurface.

9.3.1.2. Surface Soils. Elevated metals were detected in eleven of the sixteen surface soil samples and in seventeen of the nineteen boreholes in the 0-1 foot bgs interval (Figure 9-2). The most common metals detected above background were cadmium, chromium, hexavalent chromium, copper, lead, and zinc. Antimony, nickel, and manganese were also frequently detected. Only one cyanide detection was seen, at a concentration of 1.32 mg/kg. Levels of lead detected in the surface soils ranged up to 21,000 mg/kg, chromium up to 193 mg/kg, hexavalent chromium up to 18.1 mg/kg, copper up to 2,480 mg/kg, cadmium up to 109 mg/kg, and zinc up to 2,840 mg/kg. The percentage of chromium present in the hexavalent state ranged from 9 to 45 percent. The following summarize the metals results for the surface soils at SWMU 20 compared to the available risk-based guidance thresholds commonly used by the EPA as an initial screening tool for both residential and commercial/industrial scenarios (USEPA, 1994a). This is presented for comparison purposes only, and is not intended as any indication of a current or future clean-up level. A quantitative assessment of risks to human health follows in Section 9.4.



Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMU s
SWMU 20
AED DEACTIVATION FURNACE SITE
ANALYTICAL RESULTS FOR SURFACE SOILS
FIGURE 9-2

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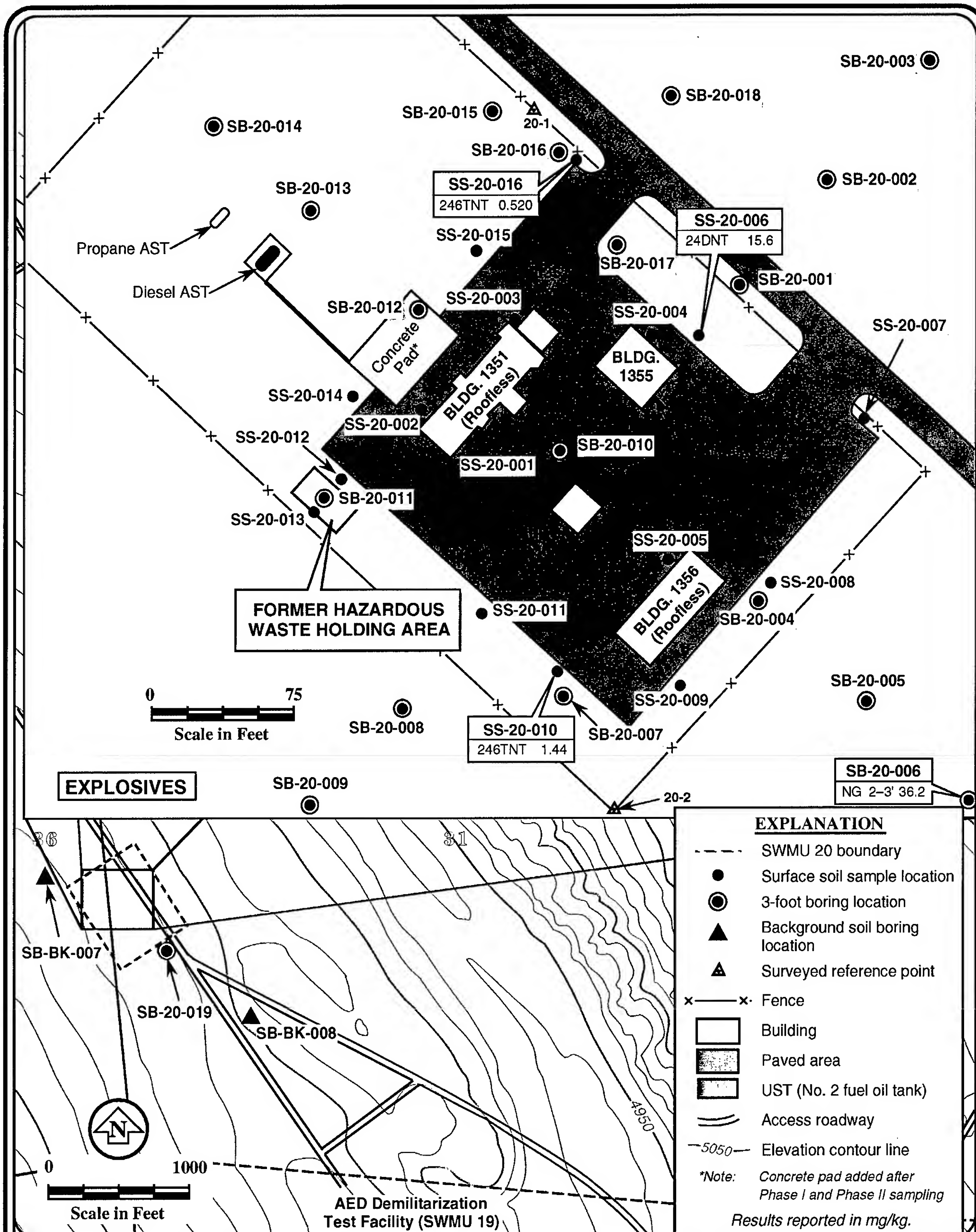
Analyte	Residential Threshold (mg/kg)	No. of Detections Exceeding Residential Threshold	Industrial Threshold (mg/kg)	No. of Detections Exceeding Industrial Threshold
SB	31	2	410	0
BA	5,500	1	72,000	0
CD	39	1	510	0
MN	390	3	5,100	0
TL	6.3	13	82	0
CR	78,000	0	1,000,000	0
CRVI	390	0	5,100	0

9.3.1.3. Two detections of 2,4,6-TNT were seen in surface soil samples at 0.52 mg/kg and 1.44 mg/kg. Both of these samples were collected from areas that receive stormwater runoff from the asphalt-covered portion of the facility. For comparison, the suggested threshold from available risk-based guidance for 2,4,6-TNT in residential soils is 39 mg/kg (USEPA, 1994a). Figure 9-3 shows the sample locations and explosives results for the surface and the shallow subsurface soils at SWMU 21.

9.3.1.4. Two surface soil samples collected from along the edge of the asphalt surface showed the presence of fuel (gasoline) components. Ethylbenzene (0.0019 mg/kg) and total xylenes (0.007 mg/kg) were detected in one sample, while another contained total xylenes at 0.0046 mg/kg. For comparison, the previously mentioned risk-based guidance for these VOC compounds suggests residential thresholds for ethylbenzene and total xylenes as 7,800 mg/kg and 16,000 mg/kg, respectively. These fuel constituents could have originated from fuel spills on the asphalt surface which have been transported by stormwater runoff to the adjacent surface soils. Figure 9-4 presents the analytical results for organic compounds in the surface soils. Neither VOCs nor SVOCs were analytes of concern for the Phase II borehole sampling.

9.3.1.5. Only one surface soil sample collected from along the edge of the asphalt surface contained dioxins and furans. The detections included OCDD at 0.000677 mg/kg, OCDF at 0.0000243 mg/kg, HPCDD at 0.0000961 mg/kg, HPCDF at 0.0000202 mg/kg, HXCDD at 0.00000738 mg/kg, HXCDF at 0.00000536 mg/kg, 2,3,7,8-TCDF at 0.00000121 mg/kg, and total TCDF at 0.0000152 mg/kg. Figure 9-5 shows the sample locations and dioxin and furan results for the surface soil samples.



Source: *Modified from USGS Grantsville 7.5 minute quadrangle.*

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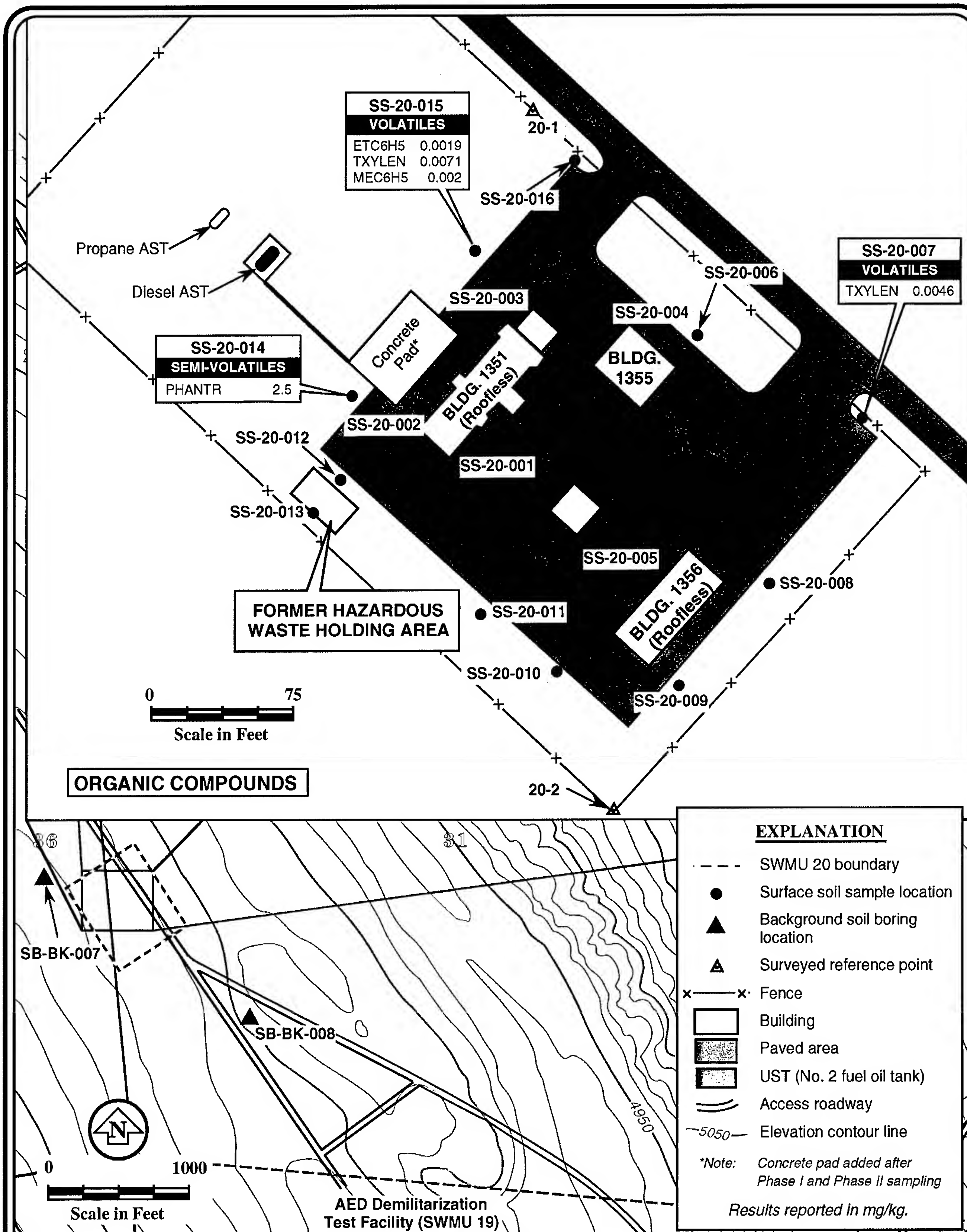
TEAD-N RFI—GROUP A SWMUs
SWMU 20
AED DEACTIVATION FURNACE SITE
ANALYTICAL RESULTS FOR SURFACE AND SHALLOW SOILS
FIGURE 9-3

PROJECT NO. 2942.0190



Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 20
AED DEACTIVATION FURNACE SITE
ANALYTICAL RESULTS FOR
SURFACE SOILS
FIGURE 9-4

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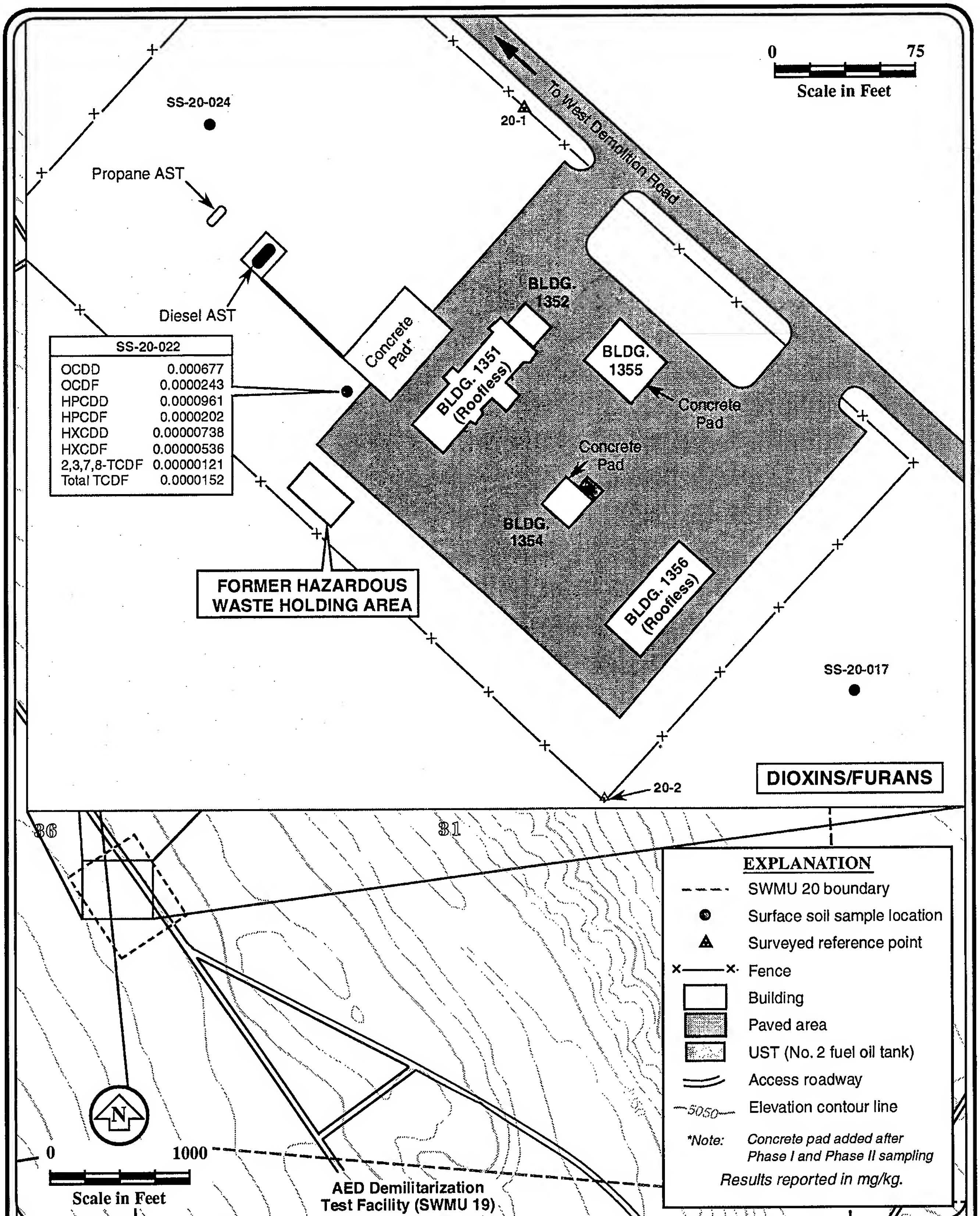

Source: Modified from USGS Grantsville 7.5 minute quadrangle.
All results in mg/kg.

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TEAD-N RFI—GROUP A SWMUs
SWMU 20
AED DEACTIVATION FURNACE SITE
ANALYTICAL RESULTS FOR SURFACE SOILS
FIGURE 9-5

PROJECT NO. 2942.0190 10/19/95

9.3.1.6. Subsurface Soils. Elevated metals concentrations were detected in the shallow subsurface soils in 15 of the 19 boreholes drilled at SWMU 20 (Figure 9-6). One or more metals were detected above background down to three feet bgs in ten boreholes. In general, the metals concentrations decrease with depth. The three boreholes that showed the most persistent metals concentrations to depth were drilled in areas that tend to collect stormwater runoff from the asphalt surface (i.e., a weathered and broken asphalt area, a depression near the asphalt edge, and a culvert outfall).

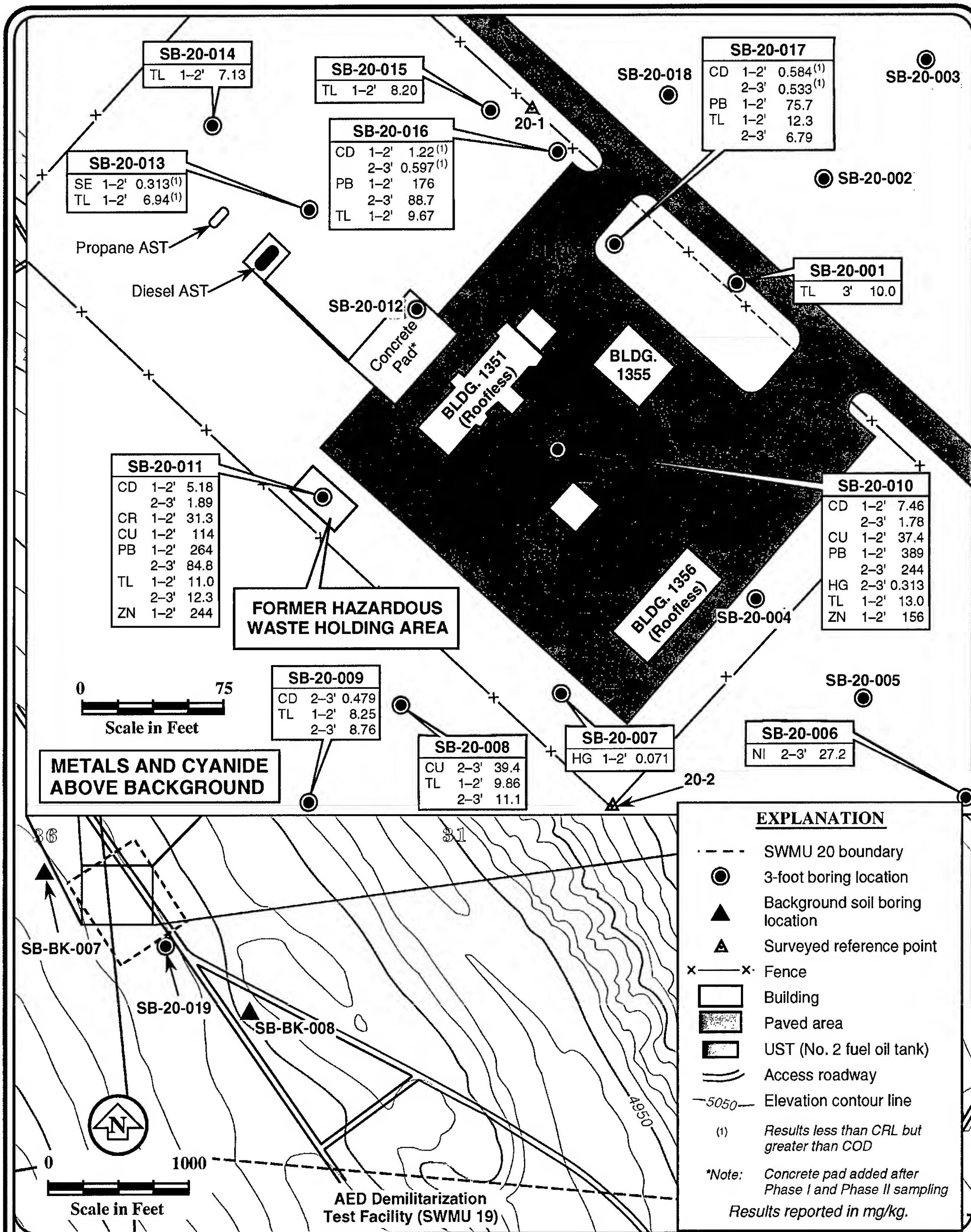
9.3.1.7. Only one explosive compound was detected in the subsurface soils. Nitroglycerin was detected at a concentration of 36.2 mg/kg at 2.5 to 3 feet bgs in soil boring SB-20-006, located about 175 feet southeast of the facility (Figure 9-3).

9.3.2. Nature and Extent of Contamination

9.3.2.1. Based on the surface soil sampling and shallow borehole sampling conducted at SWMU 20, a release of various contaminants (mainly metals) has occurred from the facility. Surface soils located adjacent to the edge of the asphalt covering show the highest levels of metals, with metals concentrations decreasing with distance from the facility. At a distance of 150 feet from the facility, elevated metals in the surface soils consist of vanadium, thallium, and chromium, of which only thallium exceeds available risk-based guidance thresholds for residential soils used for comparison purposes in this report (USEPA, 1994a). The thallium concentrations do not exceed the available guidance for industrial/commercial soils. No elevated metals or explosives were present in soil boring SB-20-019, located about 250 feet east of SWMU 20. This boring was the farthest environmental borehole from the SWMU 20 facility.

9.3.2.2. The absence of explosive compounds in the shallow boreholes, with one exception, shows the horizontal and vertical extent of explosives contamination at SWMU 20 is limited. The two detections of 2,4,6-TNT in the surface soil samples are probably the result of stormwater runoff from the asphalt surface around the furnace operation. The presence of nitroglycerin at a depth of three feet bgs away from the facility is suspect, since no nitroglycerin was detected in the two shallower intervals sampled in the borehole. No nitroglycerin was detected in any of the boreholes closer to the facility, either.

9.3.2.3. Even though the groundwater underlying SWMU 20 was not sampled, the depth to the water table, the generally alkaline nature of the soil, and the lack of a strong driving



Source: *Modified from USGS Grantsville 7.5 minute quadrangle.*

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TEAD-N RFI—GROUP A SWMUs
SWMU 20
AED DEACTIVATION FURNACE SITE
ANALYTICAL RESULTS FOR SHALLOW SUBSURFACE SOILS
FIGURE 9-6

PROJECT NO. 2942.0190

force makes it unlikely that groundwater contamination has occurred here due to AED Deactivation Furnace Site activities.

9.3.3. Selection of COPCs and COPECs

9.3.3.1. Identification of COPCs. The selection of the COPCs for the AED Deactivation Furnace Site (SWMU 20) was based on the screening procedures outlined in Section 3.2.6. A summary of all chemicals detected in soil samples from SWMU 20, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationales for the analytes excluded as COPCs are shown in Table 9-1.

9.3.3.2. Chemicals of potential concern selected for the human health risk assessment at SWMU 20 include the metals antimony, barium, cadmium, chromium, hexavalent chromium, copper, lead, mercury, thallium, zinc, dioxins, and furans. No volatile or semi-volatile chemicals were selected as COPCs because the low concentrations detected resulted in a low ranking in the concentration-toxicity screen calculations (i.e. these compounds contributed less than one percent of the total screening results).

9.3.3.3. Identification of COPECs. The COPECs were selected based on the criteria outlined in the methodology discussion (Section 3.2.7.). The COPECs that are evaluated in Tier 2 and the reason for the exclusion of analytes from further evaluation are presented in Table 9-1. The inorganic COPECs consist of antimony, barium, cadmium, lead, thallium, and zinc. The organic COPECs at SWMU 20 consist of dioxins and furans.

9.3.4. Contaminant Fate and Transport

9.3.4.1. As discussed in the preceding section, the contaminants of concern at SWMU 20 are metals, dioxins and furans. These include antimony, barium, cadmium, chromium, hexavalent chromium, copper, lead, thallium, zinc, dioxins and furans (Table 9-1). Table 3-4 briefly describes the fate and transport characteristics for all of the metals, as well as the dioxins and furans identified during the RFI. The remainder of this section will present a conceptual model of contaminant fate and transport at SWMU 20 and discuss the expected fate and transport of these contaminants.

9.3.4.2. Conceptual Model. A conceptual site model of contaminant transport has been developed (Figure 9-7) based on the physical site characteristics presented in Section 2.0

TABLE 9-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN
FOR ANALYTES DETECTED IN SOIL AT SWMU 20–AED DEACTIVATION FURNACE SITE

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluate in Risk Assessment? Human	Ecological
Aluminum	1.45E+04	100	No(d)	No(d)
Antimony	**2.03E+02**	**11**	**Yes**	**Yes**
Arsenic	1.40E+01	100	No(a)	No(f)
Barium	**5.60E+03**	**100**	**Yes**	**Yes**
Beryllium	1.02E+00	30	No(a)	No(a)
Cadmium	**1.09E+02**	**37**	**Yes**	**Yes**
Chromium	**1.93E+02**	**99**	**Yes**	**No(f)**
Hexavalent chromium	**1.81E+01**	**100**	**Yes**	**No(f)**
Cobalt	5.77E+00	100	No(a)	No(a)
Copper	**2.00E+03**	**100**	**Yes**	**No(f)**
Cyanide	1.32E+00	6	No(c)	No(f)
Lead	**2.10E+04**	**99**	**Yes**	**Yes**
Manganese	4.51E+02	100	No(a)	No(a)
Mercury	**3.13E-01**	**15**	**Yes**	**No(f)**
Nickel	1.32E+02	100	No(c)	No(f)
Selenium	3.13E-01	3	No(g)	No(f)
Silver	1.64E+00	1	No(g)	No(f)
Thallium	**2.62E+01**	**52**	**Yes**	**Yes**
Vanadium	2.32E+01	100	No(c)	No(f)
Zinc	**2.84E+03**	**100**	**Yes**	**Yes**
Ethylbenzene	2.00E-03	6	No(c)	No(f)
Toluene	2.00E-03	6	No(c)	No(f)
Phenanthrene(e)	2.50E+00	6	No(c)	No(f)
Xylenes	7.00E-03	11	No(c)	No(f)
Dioxins/Furans	**2.00E-07**	**33**	**Yes**	**Yes**

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium
Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

(a) Analyte was detected at or below background concentrations
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte contributed less than 1 percent in a concentration - toxicity screen
(d) Low toxicity metal with inadequate toxicity data
(e) The reference dose for pyrene was used in the concentration - toxicity screen
(f) Maximum concentration is less than NOAEL or estimate of NOAEL
(g) Analyte frequency of detection was less than 5 percent

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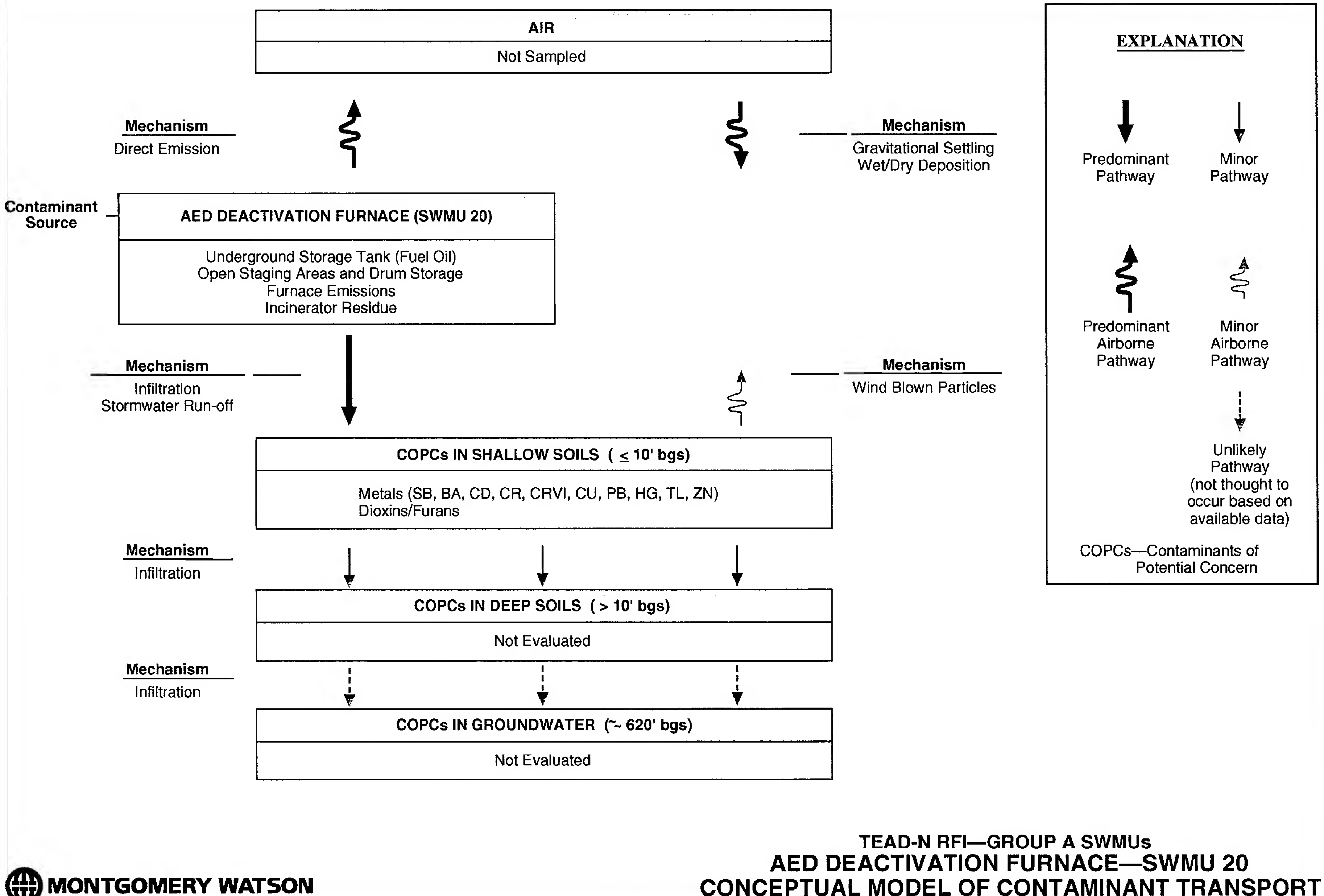

TEAD-N RFI—GROUP A SWMUs
AED DEACTIVATION FURNACE—SWMU 20
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 9-7

and the contamination assessment presented above. This model displays the potential migration routes of contaminants from the surface soil and vadose zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways through which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear unlikely based on currently available data. Contamination at SWMU 20 has been released to the surface soils. The most likely sources of this contamination are stack emissions and surface spills of incinerator residue around Buildings 1351, 1354, 1355, 1356 and the former Hazardous Waste Holding Area. Groundwater beneath SWMU 20 is approximately 620 feet bgs, and the surface and shallow soils consist of sands, sandy gravels, and gravelly loams. Surface runoff is generally to the east-northeast; no prominent drainage systems have developed near this site.

9.3.4.3. Fate and Transport of Metals. Based upon the current known conditions, it appears unlikely that metals will migrate to the groundwater. With the exception of hexavalent chromium, transport of metals from the surface soils through the deeper soil horizons to groundwater is not expected based on the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow soils, neutral to slightly basic pH soils, and depth to groundwater (more than 600 feet below the ground surface). On the other hand, hexavalent chromium is mobile in oxidizing and in basic pH soils, and may leach into deeper soils. However, the low concentrations of hexavalent chromium (≤18.1 mg/kg) make it unlikely that the ground water will be impacted. Off-site migration of metal contaminants via a surface-water pathway is not expected to be significant since soil samples collected around the perimeter of the SWMU boundary either did not detect elevated metals or detected metals concentrations only slightly elevated above background (see Figures 9-2 and 9-5). The metals at the surface may provide particulates to the air pathway at this site.

9.3.4.4. Fate and Transport of Dioxins and Furans. Several dioxin and furan compounds have been detected at SWMU 20 in surface soils. Because the geology at this site consists of abundant fine-grained particles (mostly silty sands), the dioxins and furans are expected to strongly adsorb to the soils and be immobile. Because of their strong adsorptive properties, there is little potential for these compounds to leach under normal environmental conditions. Surface water runoff will have only local transport effects (i.e., only effective in the areas adjacent to the pavement). Because these contaminants will strongly adsorb to sediments and precipitation rates are typically low.

The contaminants at the surface may provide particulates to the air pathway. Dioxins and furans are expected to be persistent in the environment.

9.4 HUMAN HEALTH RISK ASSESSMENT

9.4.0.1. The methods used to estimate the risks associated with SWMU 20 are given in Human Health Risk Assessment Methodology, Section 3.2.6. The COPCs were identified in the previous section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 20) is presented in the following sections.

9.4.1. Exposure Pathways and Receptors

9.4.1.1. The pathways quantitatively evaluated in the BRA are: (1) those that are complete or likely to be completed in the future, and (2) those that may potentially cause a significant risk. An exposure pathway diagram (a conceptual model for pathways at SWMU 20) is shown in Figure 9-8. An evaluation of pathway completeness and an assessment of whether a pathway is significant enough to require further evaluation for current and potential future receptors at SWMU 20 is given in Tables 9-2 and 9-3, respectively. Note that potential exposure pathways included in this BRA are limited to exposures to chemicals which have been released to the environment. This assessment does not address occupational exposure during furnace operations.

9.4.1.2. The current on-Depot receptors are the civilian personnel who operate the furnace at SWMU 20. Presently the furnace operates approximately one day per month. Up to three engineers spend eight hours per day, three days per month at the site. Their activities include feeding munitions into the furnace, stacking samplers, and cleaning and maintenance of the equipment. The present staff numbers six, and the staff rotates shifts at the furnace. Other receptors include surveillance personnel that are on site for an hour on the days that the furnace operates. The personnel working at SWMU 20 do not have direct contact with soil but they may have incidental ingestion, dermal, and inhalation exposure, primarily via dust. The furnace at SWMU 20 has been operated full time in recent years so exposure was calculated assuming people work a normal full-time schedule.

9.4.1.3. Potential future on-Depot receptors include construction workers and residents. As shown on the exposure pathway diagram (Figure 9-8), construction workers could be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust.

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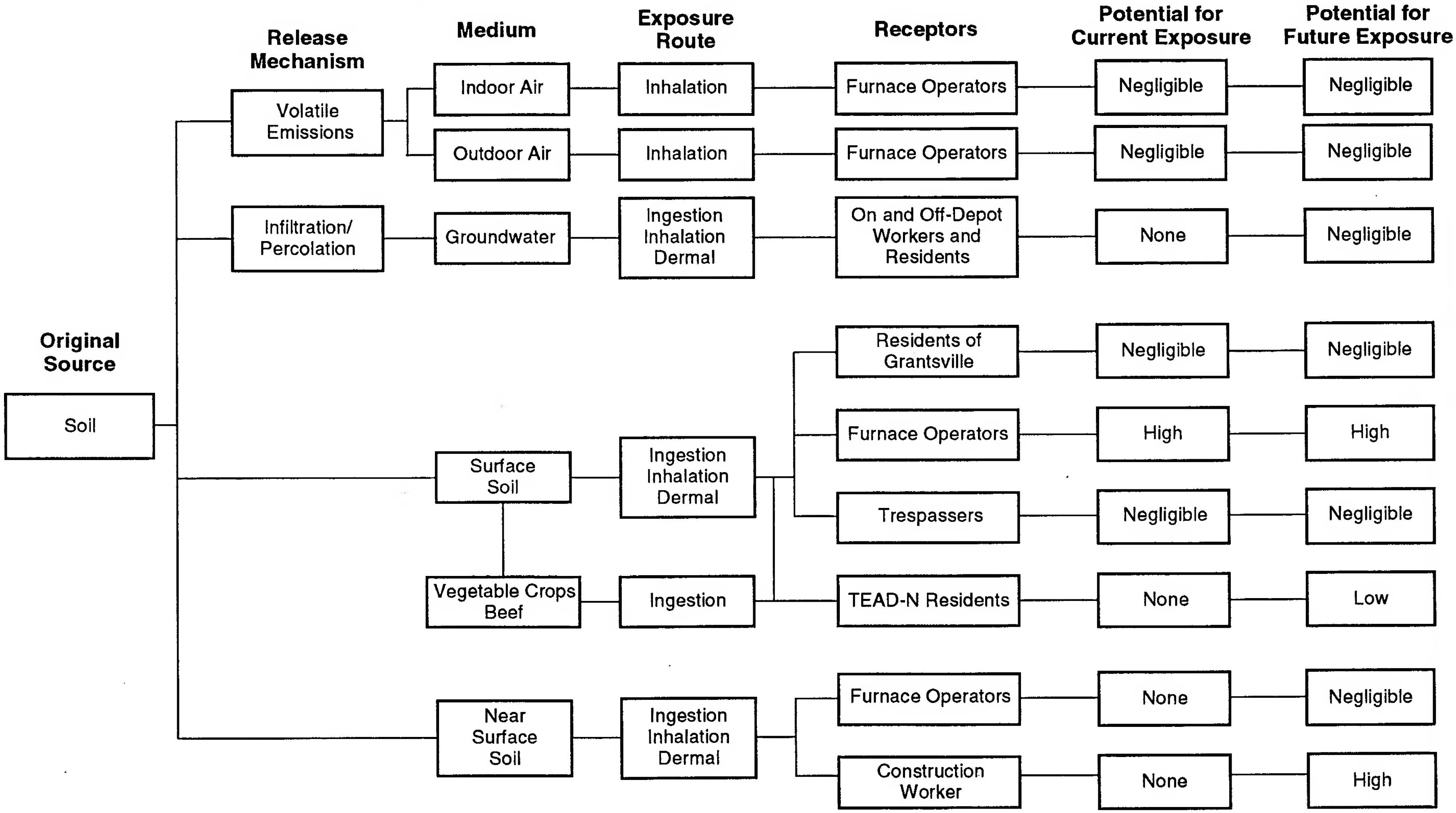


MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
AED DEACTIVATION FURNACE SITE—SWMU 20
EXPOSURE PATHWAYS DIAGRAM
FIGURE 9-8

TABLE 9-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 20: AED DEACTIVATION FURNACE SITE

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot Workers and Residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is approximately 620 feet below the below ground surface, evapotranspiration is high, and primary contaminants (i.e. metals) have low mobility.
Soil Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 20 is small and the amount of dust in Grantsville originating from SWMU 20 will be minuscule.
	Furnace Operators	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil is contaminated and Depot personnel frequent the site.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers have not been observed at this area.
Near-Surface Soil	Furnace Operators	Incidental ingestion of dust, inhalation, and dermal contact	No. Personnel activity patterns do not include intrusive activities such as excavation.
Air	Furnace Operators	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure evaluated under soil.

TABLE 9-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 20 : AED DEACTIVATION FURNACE SITE

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	Future TEAD-N residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely in the future. Groundwater is approximately 620 feet below the below ground surface, evapotranspiration is high, and primary contaminants (i.e. metals) have low mobility.
Soil Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 20 is small and the amount of dust in Grantsville originating from SWMU 20 will be minuscule.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil is contaminated and while future residential land use is not expected due to the isolation of this SWMU, it cannot be ruled out.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Furnace Operators	Incidental ingestion of dust, inhalation, and dermal contact	No. Exposure will be the same as that evaluated under current conditions.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers are unlikely and exposures will be less than current workers.
Near-Surface Soil	Construction workers	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Near-surface soil is contaminated and future construction is possible.
Air	Furnace Operators	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure evaluated under soil.

TEAD-N Tooele Army Depot North Area

For future construction workers, direct exposure results from the anticipated excavation activities associated with construction and includes subsurface soil as well as surface soil. Should this portion of the Depot be closed in the future (it is not slated for closure at this time), future residents could become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. It should be noted that a residential development is unlikely even if the Depot is closed because SWMU 20 is in a remote area. However, because of the requirements of UAC 315-101 (1994), a residential scenario was evaluated.

9.4.1.4. SWMU 20 could be converted into an area where crops are grown. However, efforts to grow vegetables in soil from adjacent areas failed (Rust E&I, 1995). The experiments included soil from an area where there was no known release of hazardous chemicals. It was concluded that the salt content of the soil was "toxic", and that vegetables could not be grown without leaching salt from the soil. Although such activities are considered unlikely, this pathway is evaluated as part of the future residential scenario.

9.4.1.5. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that graze within the SWMU boundaries for four to six months per year. The cattle graze on the grass and incidentally ingest surface soil, and people subsequently eat the beef from the cattle. This pathway is also evaluated as part of the future residential scenario.

9.4.1.6. For the pathways that were quantitatively evaluated (see Tables 9-2 and 9-3), site-specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are given in Appendix K.

9.4.2. Risk Characterization

9.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 20. The methods for calculating the risks are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

9.4.2.2. Typically, an excess lifetime cancer risk of less than 1 x 10^{-6} is acceptable, a risk greater than 1 x 10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these values may

or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects are possible. Adult blood lead levels between 10 and 15 micrograms per deciliter (μg/dl) is a benchmark range based on hypertension in adult males and transfer of lead from a pregnant mother to her fetus. For children, 10 μg/dl is the benchmark typically used by the EPA (USEPA, 1994). See Section 3.2.6. for a discussion of the calculation of blood lead concentrations for adults and children.

9.4.2.3. In addition to the calculated risk estimates, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, or future likelihood of completion, and the degree of confidence in the risk estimates. When decisions regarding whether or not a COPC pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for current furnace workers, potential future construction workers, and potential future TEAD-N area residents.

9.4.2.4. Depot Furnace Worker. The current furnace workers were assumed to be exposed to COPC in the soil from a depth of 0 to 0.5 feet. As shown in Table 9-4, the excess lifetime cancer risk for furnace workers at SWMU 20 was estimated to equal 9×10^{-7}, which is less than the benchmark of 1×10^{-6}. The cancer risk is dominated by exposure by inhalation of cadmium and chromium in dust. The total hazard index for furnace workers was estimated to equal 0.2 and the concentration of lead in blood was estimated to be 5.8 μg/dl. The hazard index is in a range where no adverse effects are expected, and the blood lead concentration is approximately half the benchmark range of 10 - 15 μg/dl.

9.4.2.5. The cancer risk is probably an overestimate. As discussed in the section on uncertainties (Section 9.4.3.), overestimates are likely to result from the assumed concentration of contaminated dust and exposure duration, and the judgmental sampling whereby samples were collected from soil suspected of having the greatest contamination. A summary of the risk estimates and qualitative factors modifying these estimates is presented in Table 9-5.

9.4.2.6. The hazard index and blood lead concentrations are in a range where no effects are expected. Because of the lack of inhalation reference doses for all compounds except barium, the inhalation pathway is largely unaccounted for in the estimate of the hazard

TABLE 9-4

SWMU 20 - AED DEACTIVATION FURNACE SITE
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FURNACE WORKERS

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	1.2E+01	NC	NC	1E-07	1E-07	14
Chromium(VI)	1.1E+01	NC	NC	8E-07	8E-07	85
Dioxins/Furans	2.0E-07	5E-09	8E-09	5E-11	1E-08	1
Pathway Total		5E-09	8E-09	9E-07		
Percent of Total		<1	<1	99		
				Total Cancer Risk:	**9E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	2.1E+01	3E-02	1E-01	NC	1E-01	60
Barium	5.4E+02	4E-03	3E-03	2E-02	3E-02	11
Cadmium	1.2E+01	6E-03	3E-03	NC	9E-03	4
Chromium(VI)	1.1E+01	1E-03	4E-04	NC	1E-03	<1
Chromium(III)	3.3E+01	2E-05	2E-05	NC	3E-05	<1
Lead	2.0E+03	NC	NC	NC	NC	NC
Mercury	3.0E-02	5E-05	1E-05	2E-06	6E-05	<1
Thallium	8.5E+00	5E-02	2E-03	NC	5E-02	23
Zinc	4.6E+02	7E-04	1E-04	NC	9E-04	<1
Pathway Total		9E-02	1E-01	2E-02		
Percent of Total		39	53	8		
				Total Hazard Index:	**2E-01**	
				Blood Lead Concentration µg/dl (95th percentile):	**5.8**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 9-5

TEAD-N BASELINE RISK ASSESSMENT
SWMU 20–AED DEACTIVATION FURNACE SITE PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (µg/dl)	Key Chemicals[a]
Furnace Workers					5.8	
Ingestion	Current likely	Medium/High	0.09	5×10^{-9}		Antimony, barium, cadmium, chromium, thallium
Dermal	Current likely	Medium/High	0.1	8×10^{-9}		
Inhalation	Current likely	High/High	0.02	9×10^{-7}		
Construction Worker					5.3	
Ingestion	Future likely	Medium/High	0.1	1×10^{-9}		Antimony, barium, chromium
Dermal	Future likely	Medium/High	0.07	3×10^{-10}		
Inhalation	Future likely	High/High	0.03	7×10^{-7}		
TEAD-N Resident					15.4	
Ingestion	Future unlikely	Medium/High	2	5×10^{-8}		Antimony, cadmium, chromium (VI), lead, thallium, dioxins/furans
Dermal	Future unlikely	High/High	0.5	2×10^{-8}		
Inhalation	Future unlikely	High/High	0.2	3×10^{-6}		
Vegetable Crops	Future unlikely	High/Neutral	8	3×10^{-7}		
Beef	Future unlikely	High/Neutral	0.001	2×10^{-10}		

TEAD-N Tooele Army Depot North Area

NC Not calculated

(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

index. However, the predicted exposure doses are in a range where adverse health effects are unlikely (see the discussion of uncertainties in Section 9.4.3.; Appendix K summarizes the exposure doses). Consequently, the absence of inhalation reference doses is not thought to result in a significant underestimate of the total hazard index.

9.4.2.7. Potential Future Construction Worker. The excess lifetime cancer risk for potential future construction workers was estimated to equal 7×10^{-7} (Table 9-6), which is less than the benchmark of 1×10^{-6}. Inhalation of chromium in dust dominated the risk. The total hazard index for potential future construction workers was estimated to equal 0.2, and the concentration of lead in blood was estimated to be 5.3 µg/dl. None of these estimates are associated with a significant potential for adverse health effects, and they are additionally expected to be overestimates of the actual risk. The one possible exception is the hazard index, which again does not account for COPCs in the inhalation pathway except for barium and mercury. However, when the magnitude of exposure doses is considered in conjunction with likely overestimates of the exposure doses, no adverse effects are expected.

9.4.2.8. Potential Future TEAD-N Resident. For SWMU 20, the cancer risk from all exposure pathways was estimated to equal 3×10^{-6} and the hazard index was estimated to equal 10. As shown in Table 9-7, the excess lifetime cancer risk for potential future residents exposed to soil at SWMU 20 was estimated to equal 3×10^{-6}. Most of the calculated cancer risk is from the inhalation of cadmium and hexavalent chromium. The total hazard index for potential future child residents exposed to soil was estimated to be three and the blood lead concentration was estimated to be 15.4 µg/dl. The majority of the hazard index is derived from the ingestion of antimony and thallium. The estimated blood lead concentration is high enough to possibly be associated with adverse effects in children. The cancer risk and hazard index from exposure to soil are at levels that may be considered significant although, because of likely overestimates in the soil ingestion rate, the exposure point concentration, and the concentration of contaminated dust, they probably do not represent a significant risk. An important consideration with respect to these risk estimates is the low probability of residents occupying this land in the future.

9.4.2.9. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 20, the estimated cancer risk is 3×10^{-7} and the hazard index is 8 (Table 9-7). The hazard index is dominated by exposure to antimony and cadmium. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has several orders of magnitude of uncertainty because of uncertainties in the plant uptake factors (see Section 9.4.3.).

TABLE 9-6

SWMU 20 - AED DEACTIVATION FURNACE SITE
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	6.0E+00	NC	NC	5E-08	5E-08	7.67
Chromium(VI)	1.1E+01	NC	NC	6E-07	6E-07	92
Dioxins/Furans	2.0E-07	1E-09	3E-10	4E-11	1E-09	<1
Pathway Total		1E-09	3E-10	7E-07		
Percent of Total		<1	<1	100		
				Total Cancer Risk:	**7E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	1.2E+01	7E-02	6E-02	NC	1E-01	68
Barium	2.9E+02	1E-02	4E-03	3E-02	4E-02	22
Cadmium	6.0E+00	1E-02	2E-03	NC	2E-02	8
Chromium(VI)	1.1E+01	1E-03	1E-04	NC	1E-03	<1
Chromium(III)	2.3E+01	5E-05	1E-05	NC	7E-05	<1
Lead	9.6E+02	NC	NC	NC	NC	NC
Mercury	3.8E-02	3E-04	2E-05	4E-05	4E-04	<1
Thallium	3.4E-01	1E-03	9E-06	NC	1E-03	<1
Zinc	7.4E+00	6E-05	2E-06	NC	6E-05	<1
Pathway Total		1E-01	7E-02	3E-02		
Percent of Total		50	36	15		
				Total Hazard Index:	**2E-01**	
		Blood Lead Concentration µg/dl (95th percentile):			**5.3**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 9-7

SWMU 20 - AED DEACTIVATION FURNACE SITE
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	1.2E+01	NC	NC	4E-07	NC	NC	4E-07	12
Chromium (VI)	1.1E+01	NC	NC	2E-06	NC	NC	2E-06	74
Dioxins/Furans	2.0E-07	5E-08	2E-08	1E-10	3E-07	2E-10	4E-07	14
Pathway Total		5E-08	2E-08	3E-06	3E-07	2E-10		
Percent of Total		2	<1	86	11	<1		
					Total Cancer Risk:		**3E-06**	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	2.1E+01	7E-01	5E-01	NC	5E+00	3E-05	6E+00	51
Barium	5.4E+02	1E-01	1E-02	2E-01	5E-01	5E-07	8E-01	7
Cadmium	1.2E+01	1E-01	1E-02	NC	3E+00	2E-06	3E+00	28
Chromium (VI)	1.1E+01	3E-02	2E-03	NC	1E-02	1E-06	4E-02	<1
Chromium (III)	3.3E+01	4E-04	7E-05	NC	1E-04	2E-08	6E-04	<1
Lead	2.0E+03	NC	NC	NC	NC	NC	NC	NC
Mercury	3.0E-02	1E-03	6E-05	1E-05	4E-03	1E-08	5E-03	<1
Thallium	8.5E+00	1E+00	9E-03	NC	2E-01	1E-03	2E+00	14
Zinc	4.6E+02	2E-02	4E-04	NC	NC	5E-05	2E-02	<1
Pathway Total		2E+00	5E-01	2E-01	8E+00	1E-03		
Percent of Total		21	4	1	74	<1		
					Total Hazard Index:		**1E+01**	

Blood Lead Concentration µg/dl (95th percentile): 15.4

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure
TEAD-N Tooele Army Depot North Area

9.4.2.10. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 20, the estimated cancer risk is 2×10^{-10} and the hazard index is 0.001 (Table 9-7). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 20 if they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

9.4.3. Uncertainties

9.4.3.1. The exposure estimates and toxicity values have associated uncertainties, the magnitude and nature of which affect the confidence in the results. Most of the uncertainties are such that risk estimates could be lower than estimated, but are unlikely to be higher. The following paragraphs discuss the uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor. These discussions are focused on elements contributing the most to overestimates of the total risk, and on those elements where risks may be underestimates. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk.

9.4.3.2. Sampling at SWMU 20 included judgmental samples from areas where stained soil was observed and areas likely to have received spills and runoff. Consequently, the exposure point concentrations are upper bound estimates from a data set that included sampling locations likely to have the highest COPC concentrations. Therefore, the exposure point concentrations should be higher than the average concentrations of the contaminants. There is greater uncertainty associated with the dioxin sampling because only one dioxin sample was collected within the work area of SWMU 20. However, the sampling was biased towards areas thought most likely to have these compounds present and the exposure point concentration for dioxins equaled the maximum detected concentration. Therefore, it is unlikely that risks have been underestimated.

9.4.3.3. Surface soil samples collected at SWMU 20 were composited from five aliquots evenly distributed on a 5-foot radius. Compositing samples adds uncertainty to the results because the data may not show local hot spots, or may under-represent a hot spot if a highly contaminated sample is blended with samples which are relatively clean. However, a potential hot spot within the 5-foot radius that was sampled would not significantly affect potential risks at the site, because potential receptors would not be exposed only to soil from an area that small for an extended period of time.

9.4.3.4. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

9.4.3.5. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical (tetraethyl lead) with a reference dose below 1×10^{-6} mg/kg/day , and could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation for metals with exposure doses greater than 1×10^{-6} were examined on a case-by-case basis. The results of this evaluation were presented in Section 9.4.2. Exposure doses are summarized in Appendix K.

9.4.3.6. Depot Furnace Worker. One factor affecting the cancer risk estimates for the furnace worker is the assumption that exposure will take place over a 25-year period. Most people change jobs or their job location changes more frequently. The resulting cancer risk would be reduced in accordance with how long a person is actually at the affected job location.

9.4.3.7. The major uncertainty related to inhalation exposure is the assumed dust level of 50 $\mu g/m^3$, which is the National Ambient Air Quality Standard for respirable dust. Because SWMU 20 is small, only a small fraction of the dust will originate within the SWMU and using a value of 50 $\mu g/m^3$ will result in an overestimate of the resulting inhalation exposure.

9.4.3.8. Uncertainties related to ingestion exposure result primarily from the soil ingestion rate. A typical ingestion rate for adults is probably closer to 25 mg/day (DTSC, 1992) than to the 50 mg/day assumed in this risk assessment. Also, while soil contaminants were assumed to be 100 percent bioavailable, the actual bioavailability may be substantially less. Uncertainties related to dermal exposure estimates have little consequence because most of the COPCs are metals, which are not readily absorbed through the skin. Dioxins/furans are the only organic COPCs, and their dermal permeability has been well studied and thus have less uncertainty. Consequently, the dermal route is minor compared to ingestion and inhalation, and the uncertainties in the dermal route will not affect the overall risk estimates.

9.4.3.9. Construction Worker. Uncertainties associated with the exposure dose for a construction worker are high. For excavation work at SWMU 20, the exposure point concentrations below the ground surface are a source of uncertainty. Samples collected from a depth of three feet had lower concentrations of COPCs than surface soil samples, but surface soil samples are weighted more heavily in estimating exposure point concentrations because more of these samples have been collected (i.e., they constitute a larger fraction of the sample population). If construction workers are exposed to a higher proportion of subsurface soil than surface soil, the exposure point concentrations will be biased high.

9.4.3.10. As discussed for SWMU 1 (Section 5.4.3.), a reasonable ingestion rate is probably a factor of 3.5 less than the 480 mg/day used in this risk assessment. Also, the bioavailability of the contaminants in the soil is likely to be less than the 100 percent assumed for the BRA, further reducing the actual dose and corresponding risk. As with the furnace worker, uncertainties related to inhalation exposure are primarily associated with the dust concentration. The BRA assumed a dust concentration of 1 mg/m^3, which is at the upper end of the range of dust levels measured while digging test pits at SWMU 1 (most of the time dust levels were one to two orders of magnitude lower). The high dust levels were from wind-generated dust, rather than from the trenching work.

Wind-generated dust would include soil from both inside and outside the SWMU, with the fraction generated inside SWMU 20 expected to be small. It is possible that dust levels in a large construction project would generate more dust than an individual backhoe. Unless an actual construction project generates dust levels on the order of 1 mg/m^3, the net effect of these considerations is that typical dust levels would probably be one or more orders of magnitude less than the 1 mg/m^3 assumed in this BRA.

9.4.3.11. TEAD-N Residents. The uncertainties for construction and furnace workers also apply to the evaluation of future residents at TEAD-N, although the magnitude of the uncertainties differs, and the likelihood of pathway completion must be considered. In a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure and, to a lesser extent, the potential for dermal and ingestion exposure. As in the case of the workers, uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the dust level. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who intentionally eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate could exceed the assumed rate of 200 mg/day.

9.4.3.12. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

9.4.3.13. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53. While uptake factors for metals are based on empirical data, they have uncertainties of a similar magnitude due to the factors described in the previous paragraph. In addition, because the salt content of the soil is currently toxic to plants (see Section 9.4.1.4.), the soil would

need to be diluted with peat or other soil amendments to grow produce. This has not been accounted for in the exposure calculations. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

9.4.4. Recommendations

9.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Allow unrestricted use of this site as long as it remains part of the depot

- Evaluate the need for institutional controls and/or corrective action for possible risks in a Corrective Measures Study should this land no longer be controlled by the depot.

9.5 ECOLOGICAL RISK ASSESSMENT

9.5.0.1. This section discusses the results of the Tier 1 and Tier 2 ecological evaluations. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4.

9.5.1. Tier 1

9.5.1.1. Ecological Receptors. The area within SWMU 20 has been disturbed and supports a variety of weedy species including cheatgrass, fixweed, annual sunflower, white horehound, and pepperweed. Crested wheatgrass and big sagebrush occur along the SWMU boundary and in undisturbed areas. These species are abundant, along with red three-awn and matchweed. Native species included red three-awn, big sagebrush and matchweed. Utah junipers occur at a distance of approximately 50 yards from SWMU 20. The mapped range and soil type are:

Range Site: Semi-Desert Gravelly Loam
Soil Type: Hiko Peak gravelly loam with 2-15 percent slopes

9.5.1.2. Expected Climax Vegetation. The range site describes the climax vegetation expected to occur at each site due to the combined influence of several characteristic

environmental factors. Big sagebrush is expected, and is the dominant and most conspicuous plant species around the SWMU perimeter. Other dominant species expected in the semi-desert gravelly loam range site are bluebunch wheatgrass, Indian ricegrass, Douglas rabbitbrush, bottlebrush squirreltail and Hood phlox (USSCS, 1991).

9.5.1.3. Wildlife. No reptiles were observed at SWMU 20. Based on sightings elsewhere at the Depot, the collared and side-blotched lizard, the western whiptail, the Great Basin rattlesnake, and the gopher snake may be inhabitants at or near SWMU 20.

9.5.1.4. Although no small mammals were observed at SWMU 20, rabbit pellets from black-tailed jackrabbits and cottontail rabbits were observed, as well as valley pocket gopher mounds. Based on observations elsewhere at the Depot and the type of habitat, the common small mammal species that are probably inhabitants at SWMU 20 include the Ord's kangaroo rat, the deer mouse, Great Basin pocket mouse, pinyon mouse, sagebrush vole, the desert woodrat, and the little pocket mouse (Burt and Grossenheider, 1980; RUST, 1994). There is no evidence from the field surveys that large mammals are habitually present at SWMU 1d. However, large mammals such as the coyote (personal communication, Dr. J. Merino), mule deer, and pronghorn antelope may occur at SWMU 1d on an intermittent basis.

9.5.1.5. Raptors such as the golden eagle, American kestrel, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, red-tailed hawk, and the great-horned owl have been observed in other areas of TEAD-N but not at SWMU 20. Because of the typical range of these species during foraging/hunting activities, raptors may be at SWMU 20 on an intermittent basis.

9.5.1.6. No passerine or other birds were observed during the site visit. The sage grouse, a State of Utah sensitive species, may inhabit the undisturbed areas near the SWMU. Other non-game birds such as crows and several families of passerine birds would be expected.

9.5.1.7. Results of the Tier 1 Ecological Assessment. The field surveys indicate that the vegetation at SWMU 20 has been impacted to a greater degree by the physical activities at the site (i.e., clearing activities) than by the chemicals that may have been released. The ecological assessment, therefore, addresses only the potential adverse impact to the wildlife receptors; it is not deemed necessary to address the ecological effects on the vegetation. The ecological assessment is performed with the assumption

10.0 DEACTIVATION FURNACE BUILDING (SWMU 21)

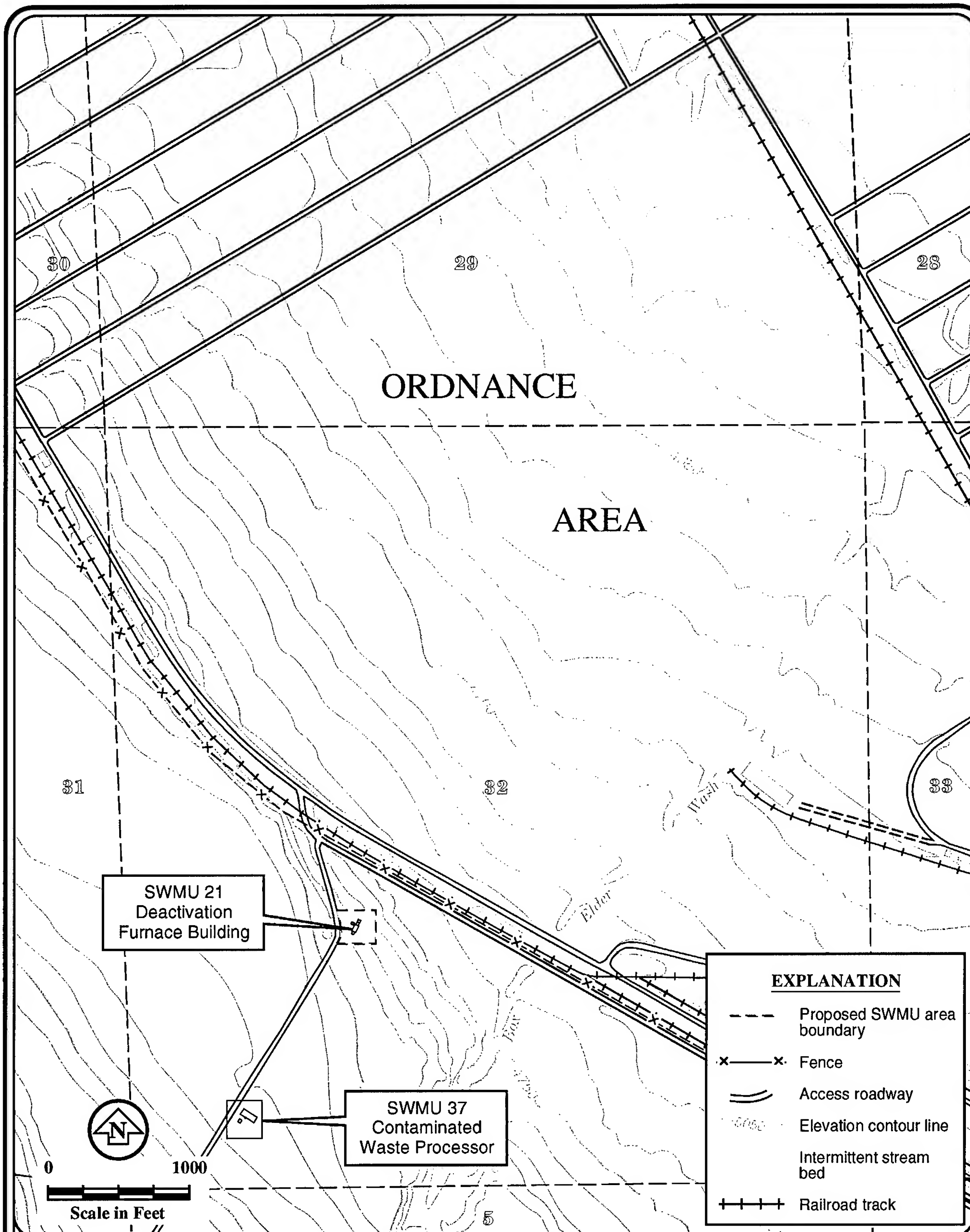
10.1. SITE BACKGROUND

10.1.0.1. Site Description. The Deactivation Furnace Building (Building 1320) is located in the southwestern portion of TEAD-N near the southwestern perimeter of the Ordnance Area, as shown in Figure 10-1. This site is an ammunition demilitarization production facility constructed about 1955, and currently operates under a RCRA Part B Permit. The facility consists of Building 1320, which contains a rotary kiln, and open staging and support equipment areas around the outside of the building. The staging areas are partially asphalt-covered and partially covered with gravelly soils. The Deactivation Furnace Building site was fenced in 1993, and comprises about 0.7 acres in size.

10.1.0.2. The rotary kiln, an auger-feed type, was installed in 1955 (NUS, 1987) and fired by fuel oil supplied from an underground storage tank located immediately west of Building 1320. More recently, an above ground fuel tank was installed east of the facility for this purpose, and sits on a sealed, bermed concrete pad designed to catch any release that might occur. A propane tank is also located east of Building 1320.

10.1.0.3. Operational Activities. The deactivation furnace in Building 1320 is used for deactivating small arms ammunition (up to 20 millimeter), primers, and fuses (Rhea, 1990). Air pollution control equipment, including a cyclone, gas cooler, and baghouse, was installed in approximately 1975 to treat emissions from the furnace (Rhea, 1990). Incinerator residue, consisting of ash and metal debris from the demilitarized munitions is collected at the south end of the furnace where it is loaded into 55-gallon drums for temporary storage and subsequent disposal.

10.1.0.4. Geology and Hydrology. Local soils on which the Deactivation Furnace Building is located are composed of eolian sands and silty sands of the Berent soil type (USSCS, 1991), which are part of the Berent-Hiko Peak Complex. The facility sits on a base of imported gravel fill. The approximate depth to groundwater is about 400 feet bgs, with groundwater flow toward the north/northeast (JMM, 1988). The depth of the underlying bedrock is approximately 500 feet bgs (ERTEC, 1982). The Deactivation Furnace Building is located approximately 1,200 feet northwest of Box Elder Wash, and surface water run-off from the site drains toward the northeast.



Source: *Modified from USGS Grantsville 7.5 minute quadrangle.*

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TEAD-N RFI—GROUP A SWMUs

SWMU 21

DEACTIVATION FURNACE BUILDING

LOCATION MAP

FIGURE 10-1

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10.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

10.2.1. Previous Investigations

10.2.1.1. Prior to the Phase I RFI, previous investigations at the Deactivation Furnace Building were limited to analyses of baghouse dust and dust from the floor of the facility. Samples were analyzed for characteristic toxicity according to TCLP. The results indicated that the baghouse dust exhibited the characteristics of a hazardous waste due to elevated levels of cadmium (60 mg/L) and lead (69 mg/L) in the leachate. The baghouse dust sample also contained elevated levels of cresols and total metals including barium, cadmium, lead, chromium, and nickel (Rasmussen, 1991). The sample of dust from the floor of the facility contained detectable concentrations of lead, barium, and cadmium, but all were below the EP Toxicity limits (Bishop, 1990).

10.2.2. RFI Sampling Summary

10.2.2.1. Phase I Sampling. During Phase I RFI sampling in July 1992, 10 surface soil samples were collected from locations around the outside of the facility and beneath the staging areas. The samples were collected from the imported gravel fill used during the construction of the furnace building and surrounding support areas. Sample locations were sited to give general coverage around the perimeter of Building 1320 with the objective of establishing the presence or absence of released contamination at this site. The majority of these samples were collected along the edges of asphalt or concrete areas that would receive stormwater runoff. All samples were analyzed for metals, VOCs, SVOCs, dioxins/furans, explosives, and selected anions.

10.2.2.2. Phase II Sampling. Because the deactivation furnace at SWMU 21 currently is a RCRA Part B permitted facility, future environmental sampling will be required at closure. To avoid redundancy of effort, the decision was made by the Army, in agreement with regulatory personnel, to conduct no further environmental sampling under the Corrective Action Permit. However, due to concerns regarding a nearby water source and overflow area, one surface water sample and two sediment (saturated soil) samples were collected in October, 1993 and submitted for total metals, dioxins/furans, and explosives analyses. The surface water sample was collected from a metal trough about 125 feet east of Building 1320 where a steady flow of water from TEAD-N Water Supply Well 4 provides a water source for livestock and wildlife. The water overflowing the trough has created a wet area for 75 to 100 feet downhill from the trough. The

sediment samples were collected from the saturated surface soil in this wet area, rather than from material accumulated or precipitated in the bottom of the trough. Because of this, the metals analytical results from the sediment samples will be compared to the soil background thresholds. Water from Supply Well 4 is also used for human consumption and is tested periodically, as required by State of Utah and federal regulations.

10.2.2.3. Because elevated levels of chromium were seen in several of the Phase I soil samples, four surface soil samples were collected at SWMU 21 and submitted for total chromium and hexavalent chromium analysis. These samples were collected to estimate the amount of chromium present as hexavalent chromium (the most toxic valence state of chromium) in the surface soils at SWMU 21.

10.2.2.4. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that all of the SWMU 21 data are usable. One soil sample was qualified as estimated for mercury and one surface water sample was qualified as estimated for thallium by Montgomery Watson chemists due to MS/MSD nonconformances. However, no data for this SWMU were rejected; therefore, 100 percent completeness was achieved. Further details concerning the data review are presented in Appendix E of this document.

10.2.2.5. The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviation and DQOs were met. Due to this, no data gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

10.3 CONTAMINATION ASSESSMENT

10.3.1. RFI Sampling Results

10.3.1.1. Soils. Contaminants detected in the surface soil samples included elevated metals, cyanide, organic compounds (VOCs and SVOCs), dioxins/furans, explosive compounds, and elevated anions. As shown in Figure 10-2, elevated levels of numerous metals were detected in all of the soil samples. Concentrations of lead ranged up to 26,000 mg/kg, or 2.6 percent. Concentrations of cadmium up to 904 mg/kg and chromium up to 7700 mg/kg were detected. Cyanide also was detected in three soil samples, with one concentration at 690 mg/kg. For comparison purposes, the following

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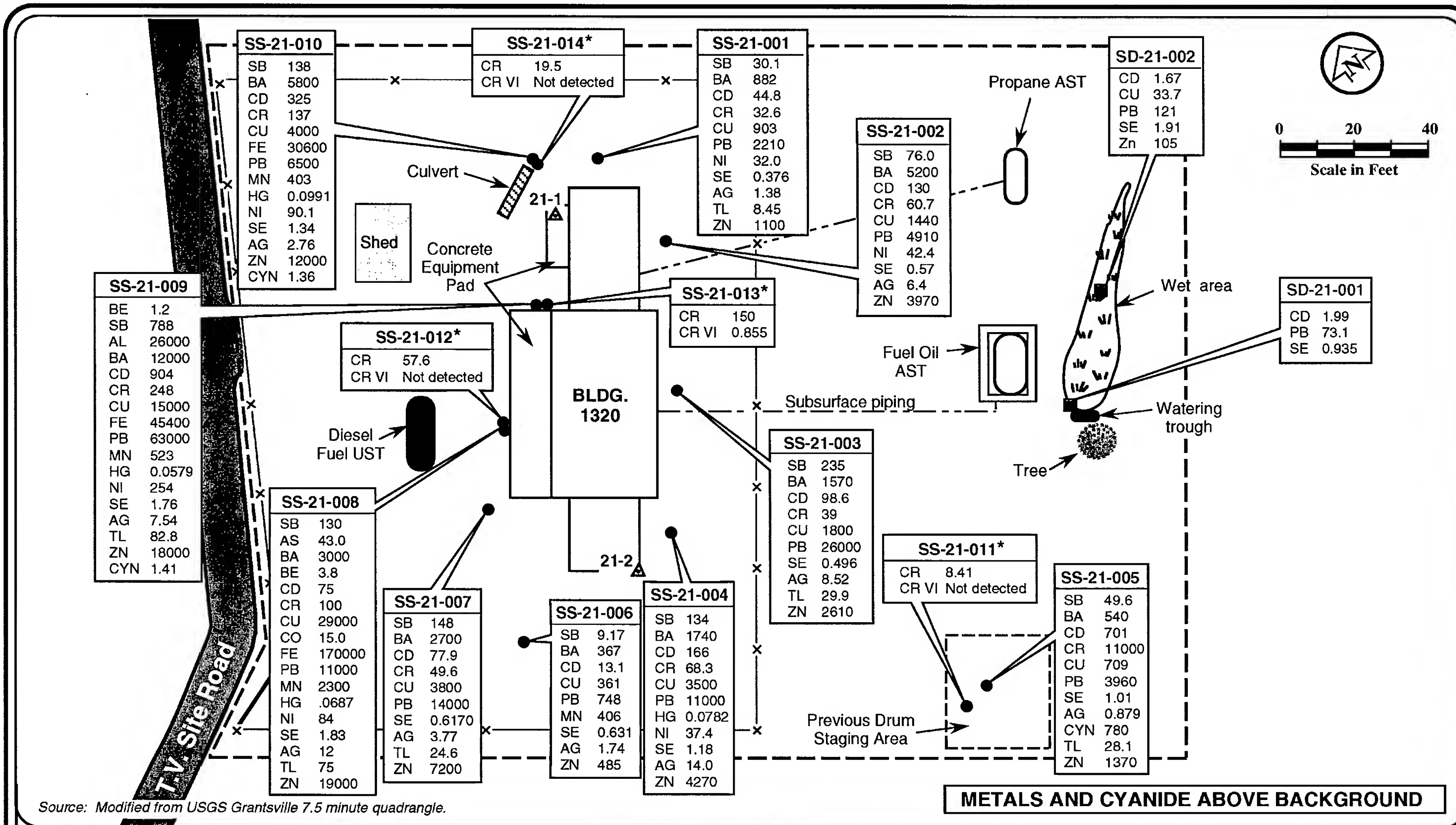

Source: Modified from USGS Grantsville 7.5 minute quadrangle.

Results in mg/kg.

EXPLANATION

- SS-21-001 ● Surface soil sample location
- SD-21-001 ■ Sediment sample location
- 21-2 △ Surveyed reference point
- – – – – Proposed SWMU area boundary
- x——x Fence
- (1) *Result between CRL and criteria of detection (COD); method not performance demonstrated*
- * *Sampled only for total CR and hexavalent CR*

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TEAD-N RFI—GROUP A SWMUs
DEACTIVATION FURNACE BUILDING—SWMU 21
SURFACE SOIL AND SEDIMENT SAMPLES
FIGURE 10-2

table summarizes the metals that were detected above suggested risk-based thresholds for residential and commercial/industrial soils scenarios (USEPA, 1994a):

Analyte	Residential Threshold (mg/kg)	No. of Detections Exceeding Residential Threshold	Industrial Threshold mg/kg	No. of Detections Exceeding Industrial Threshold
Antimony (SB)	31	7	410	1
Arsenic (AS)	0.37	1	1.6	1
Barium (BA)	5,500	2	72,000	0
Beryllium (BE)	0.15	1	0.67	1
Cadmium (CD)	39	9	510	1
Hexavalent Chromium (CR VI)	390	0	5,100	0
Copper (CU)	2,900	5	38,000	0
Thallium (TL)	6.3	10	82	1
Cyanide (CYN)	390	1	5,100	0

10.3.1.2. The results of the four surface soil samples collected to estimate chromium speciation are also shown on Figure 10-2. Two of these samples showed elevated concentrations of total chromium above background (i.e., chromium contamination). Of these two samples, one (SS-21-013) contained a detectable amount of hexavalent chromium at a concentration less than 1 mg/kg.

10.3.1.3. Detectable levels of dioxins/furans were also present in all surface soil samples collected at this SWMU (Figure 10-3). Although several of these compounds were detected at concentrations above the one μg/kg benchmark, the most toxic isomer (2,3,7,8-TCDD) was not detected. The hexachlorodibenzo-dioxin (HXCDD) isomer was detected in three of the soil samples at concentrations of 0.0005, 0.0007, and 0.0002 mg/kg. For comparison, the risk-based screening thresholds for HXCDD for residential and commercial/industrial scenarios are 0.00019 mg/kg and 0.00046 mg/kg, respectively (USEPA, 1994a). The highest levels of three isomers of both dioxins and furans were detected in a sample collected from a culvert outfall area where stormwater runoff collects.

10.3.1.4. Several explosives were detected in five of the ten surface soil samples collected, as shown in Figure 10-3. Although most of these compounds were in the range of one to ten mg/kg, one sample from a previous drum staging area about 100 feet southeast of the facility contained 16,000 mg/kg (1.6 percent) of TNT and 48 mg/kg of 1,3,5-TNB. These concentrations exceed the risk-based concentration thresholds of 3.9 mg/kg and 39 mg/kg for TNB and TNT, respectively, in residential soils (USEPA,

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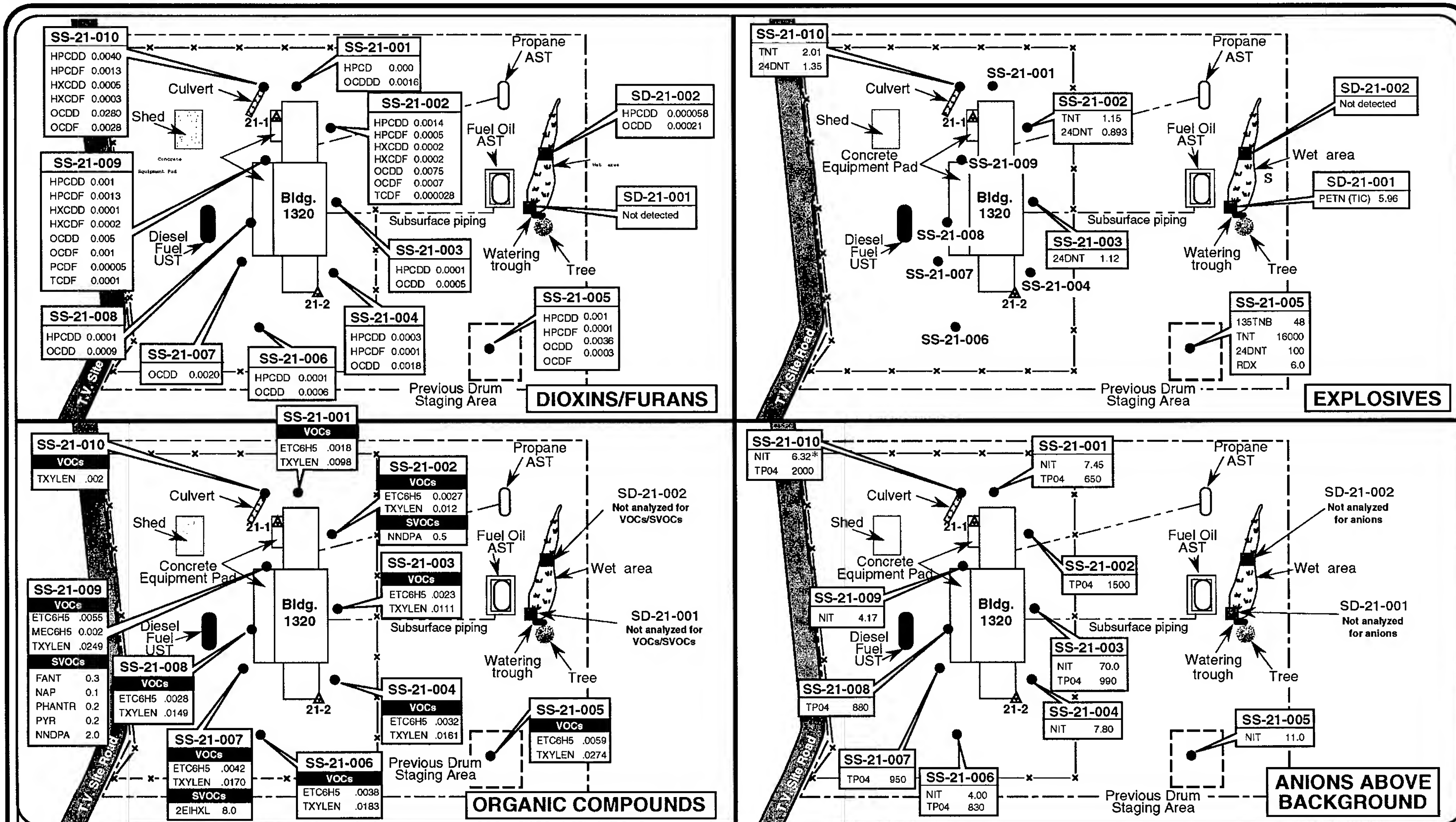

Source: Modified from USGS Grantsville 7.5 minute quadrangle.

EXPLANATION

- SS-21-006 ● Surface soil sample location
- SD-21-001 ■ Sediment sample location
- *Results in mg/kg.*
- ― ― ― Proposed SWMU area boundary
- -x―x- Fence
- 21-2 ▲ Surveyed reference point
- * *Data considered estimated. Refer to Appendix E.*

0 40 80
Scale in Feet

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DEACTIVATION FURNACE BUILDING—SWMU 21
SURFACE SOIL AND SEDIMENT SAMPLES
FIGURE 10-3

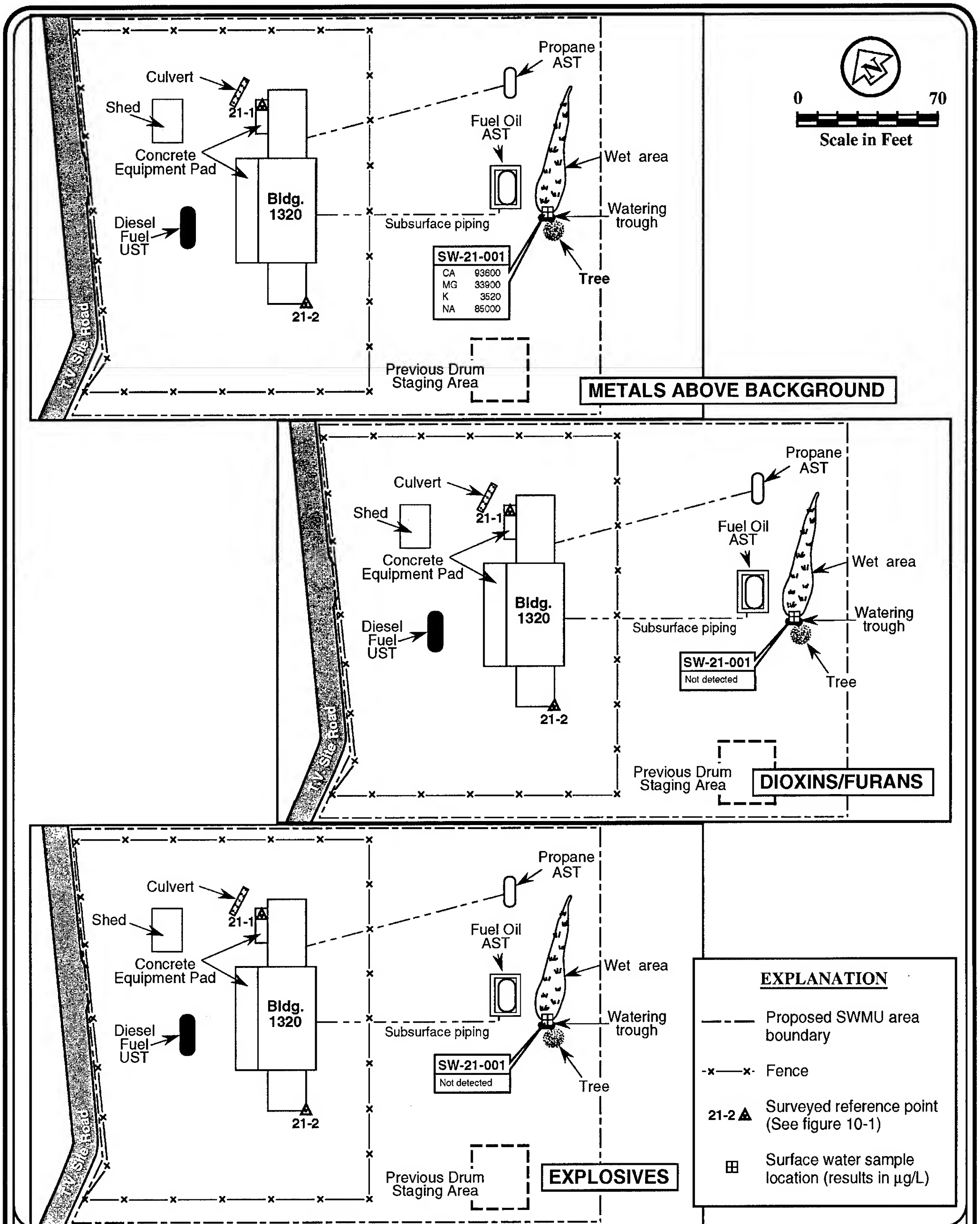
1994a). This sample was collected from an area of visibly stained surface soil, which was removed when the sampling results were received. Concentrations of 2,4-DNT also were detected in five of the samples.

10.3.1.5. VOCs and SVOCs were also detected in the surface soils at SWMU 21 (Figure 10-3). Ethylbenzene and total xylene were found in all 10 samples at concentrations below 0.1 mg/kg. These concentrations are well below available risk-based soil threshold guidelines for these compounds (USEPA, 1994a). Toluene also was detected, but the data evaluation for the Phase I data has concluded that this compound is a laboratory contaminant. Ethylbenzene and xylenes are components in many types of fuel. Since the kiln is fired by fuel oil, their presence is suspected to be related to fuel spills. Three samples contained detectable concentrations of SVOCs. One of these samples contained six SVOCs ranging from 0.1 to 2.0 mg/kg, while the other contained 8 mg/kg of one SVOC (2-ethyl-1-hexanol). The SVOCs are PAHs, which are typical components of incinerator residue. All SVOC concentrations were below available risk-based soil guidance levels, where established (USEPA, 1994a).

10.3.1.6. Elevated levels of nitrates and/or total phosphates were found in all the surface soil samples. These compounds may be naturally occurring or could be present as combustion products from the incineration of explosives. The results for anions analyses are also shown on Figure 10-3.

10.3.1.7. Sediment. The explosive compound pentaerythritol tetranitrate (PETN) was detected as a tentatively identified compound (TIC) in sediment (saturated soil) sample SD-21-001 at 5.96 mg/kg. The dioxin compounds OCDD and HPCDD were detected in sediment sample SD-21-002 up to .00021 mg/kg. Explosives and dioxin results are shown on Figure 10-3. Cadmium, lead, selenium, and thallium were detected in the sediment samples at levels only slightly above background. Of these metals, only the thallium concentrations exceed available risk-based guidance thresholds for a residential soil of 6.3 mg/kg established for thallium chloride (USEPA, 1994a). Metals results for the sediment samples are shown on Figure 10-2.

10.3.1.8. Surface Water. As shown on Figure 10-4, no detectable levels of dioxins, furans, or explosives were found in the surface water sample. Of the metals, only barium (34.1 µg/L), calcium (93,600 µg/L), magnesium (33,900 µg/L), potassium (3,250 µg/L), and sodium (85,000 µg/L) were detected. For comparison, the Safe Drinking Water Act maximum contaminant level (MCL) for barium is 2,000 µg/L



Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
DEACTIVATION FURNACE BUILDING—SWMU 21
SURFACE WATER SAMPLE RESULTS
FIGURE 10-4

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10.3.2. Nature and Extent of Contamination

10.3.2.1. Based on the results of the soil sampling program conducted during the RFI, it is apparent that various types of chemicals including metals, VOCs, SVOCs, explosives, and dioxins/furans have been released to the surface soils at SWMU 21. The soil samples collected to date represent surficial conditions in close proximity to the furnace building in areas that would directly receive stormwater runoff from the surrounding asphalt or concrete surfaces. Because of this, the contaminant levels in these soil samples may be high when compared to areas more distant from the furnace building, even on the scale of 10 to 100 feet. The contaminant levels in the two saturated soil samples, located 100 to 150 feet east of Building 1320, are significantly lower than those found in the soil samples adjacent to the facility. The presence of detectable amounts of dioxin compounds in the sediment samples may, however, show some movement away from the facility, possibly through airborne transport from the furnace stack. Because no dioxins, explosives, or elevated metals were identified in the surface water, these compounds could be present in the soil here as airborne or runoff products from SWMU 21.

10.3.2.2. While the presence and nature of environmental contamination has been established at SWMU 21, the horizontal and vertical extent of contamination cannot be defined until further sampling occurs upon closure of this facility.

10.3.3. Selection of COPCs and COPECs

10.3.3.1. Introduction. A summary of all chemicals detected in samples from SWMU 21, the maximum concentration detected, the frequency of detection, which analytes are considered COPCs, and the rationales for the analytes excluded as COPCs are shown on Table 10-1.

10.3.3.2. Identification of COPCs. Inorganic chemicals of potential concern selected for the human health risk assessment at SWMU 21 include antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, manganese, mercury, thallium, and zinc. Organic chemicals of concern include 2,4,6-TNT and dioxins and furans. The selection of COPCs was in accordance with the methodology outlined in Section 3.2.6. with the exception of chromium. For the screening, 100 percent of the chromium was assumed to be in the hexavalent (most toxic) oxidation state, an unlikely condition.

TABLE 10-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN FOR ANALYTES DETECTED IN SURFACE SOIL AT SWMU 21 - DEACTIVATION FURNACE BUILDING

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluate in Risk Assessment?	
			Human	Ecological
Aluminum	2.60E+04	100	No(e)	Yes
Antimony	**7.88E+02**	**100**	**Yes**	**Yes**
Arsenic	**4.30E+01**	**100**	**Yes**	**Yes**
Barium	**1.20E+04**	**100**	**Yes**	**Yes**
Beryllium	**3.80E+00**	**90**	**Yes**	No(g)
Cadmium	**9.04E+02**	**100**	**Yes**	**Yes**
Chromium	**2.48E+02**	**100**	**Yes**	**Yes**
Cobalt	1.50E+01	100	No(e)	No(g)
Copper	**2.90E+04**	**100**	**Yes**	**Yes**
Cyanide	7.35E+02	30	No(d)	Yes
Lead	**6.30E+04**	**100**	**Yes**	**Yes**
Manganese	**2.30E+03**	**100**	**Yes**	**Yes**
Mercury	**9.90E-02**	**50**	**Yes**	No(g)
Nickel	2.54E+02	100	No(d)	Yes
Selenium	1.83E+00	100	No(d)	No(g)
Silver	1.40E+01	100	No(d)	No(g)
Thallium	**8.28E+01**	**100**	**Yes**	**Yes**
Vanadium	1.73E+01	90	No(a)	No(g)
Zinc	**1.90E+04**	**100**	**Yes**	**Yes**
2,4-Dinitrotoluene	9.10E+01	40	No(d)	Yes
2,4,6-Trinitrotoluene	**2.01E+00**	**30**	**Yes**	**Yes**
Cyclonite (RDX)	5.75E+00	10	No(d)	No(g)
Di-n-butyl phthalate	7.00E+00	50	No(d)	No(g)
Dioxins/Furans(f)	**2.70E-05**	**90**	**Yes**	No(g)
Ethylbenzene	6.00E-03	90	No(d)	No(g)
n-Nitrosodiphenylamine	2.00E+00	20	No(d)	No(g)
Naphthalene	2.00E-01	10	No(d)	No(g)
Phenanthrene	2.00E-01	10	No(d)	No(g)
Pyrene	2.00E-01	10	No(d)	No(g)
Toluene	2.00E-03	40	No(d)	No(g)
Xylenes	2.50E-02	100	No(d)	No(g)

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium.
Chemicals of potential concern for evaluation in risk assessment are depicted with their chemical name in bold print.

(a) Analyte was detected at or below background concentrations
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte frequency of detection was less than 5 percent
(d) Analyte contributed less than 1 percent in a concentration - toxicity screen (see Appendix K)
(e) Low toxicity metal with inadequate toxicity data
(f) Concentration based on toxicity equivalence factors
(g) Maximum concentration is less than NOAEL or estimate of NOAEL

10.3.3.3. No chemicals will be evaluated in the human risk assessment for the surface water and sediment associated with the stock watering trough because the exposure pathways are incomplete (see discussion in Section 10.4.2).

10.3.3.4. Identification of COPECs. The COPECs were selected based on the criteria outlined in the methodology discussion (Section 3.2.7.). The COPECs that are evaluated in Tier 2 and the reason for the exclusion of analytes from further evaluation are presented in Table 10-1. The inorganic COPECs consist of aluminum, antimony, arsenic, barium, cadmium, chromium, copper, cyanide, lead, manganese, nickel, thallium, and zinc. The organic COPECs at SWMU 21 are 2,4-DNT and 2,4,6-TNT.

10.3.4. Contaminant Fate and Transport

10.3.4.1. As discussed in the preceding section, the contaminants of concern at SWMU 21 include metals, explosives, dioxins, and furans (Table 10-1). Table 3-4 briefly describes the fate and transport characteristics for each of the contaminants of concern identified in Table 10-1. The remainder of this section will present a conceptual model of contaminant fate and transport at SWMU 21 and discuss the expected fate and transport of metals, explosives, and dioxins and furans.

10.3.4.2. Conceptual Model. A conceptual site model of contaminant transport (Figure 10-5) has been developed based on the physical site characteristics presented in Section 2.0 and the contamination assessment presented above. This model displays the potential routes of contaminant migration from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear unlikely based on available data. Contamination has been released to the surface soils at SWMU 21 from stack emissions and surface spills of incinerator residue around Building 1320 and at the previous drum staging area (Figure 10-2). The surface and shallow subsurface soils at SWMU 21 consist of sands and silty sands, and surface runoff is toward the northeast. Depth to groundwater is about 400 feet bgs.

10.3.4.3. Fate and Transport of Metals. Transport of metals from the surface soils at SWMU 21 through the deeper soil horizons to groundwater is not expected based on the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow

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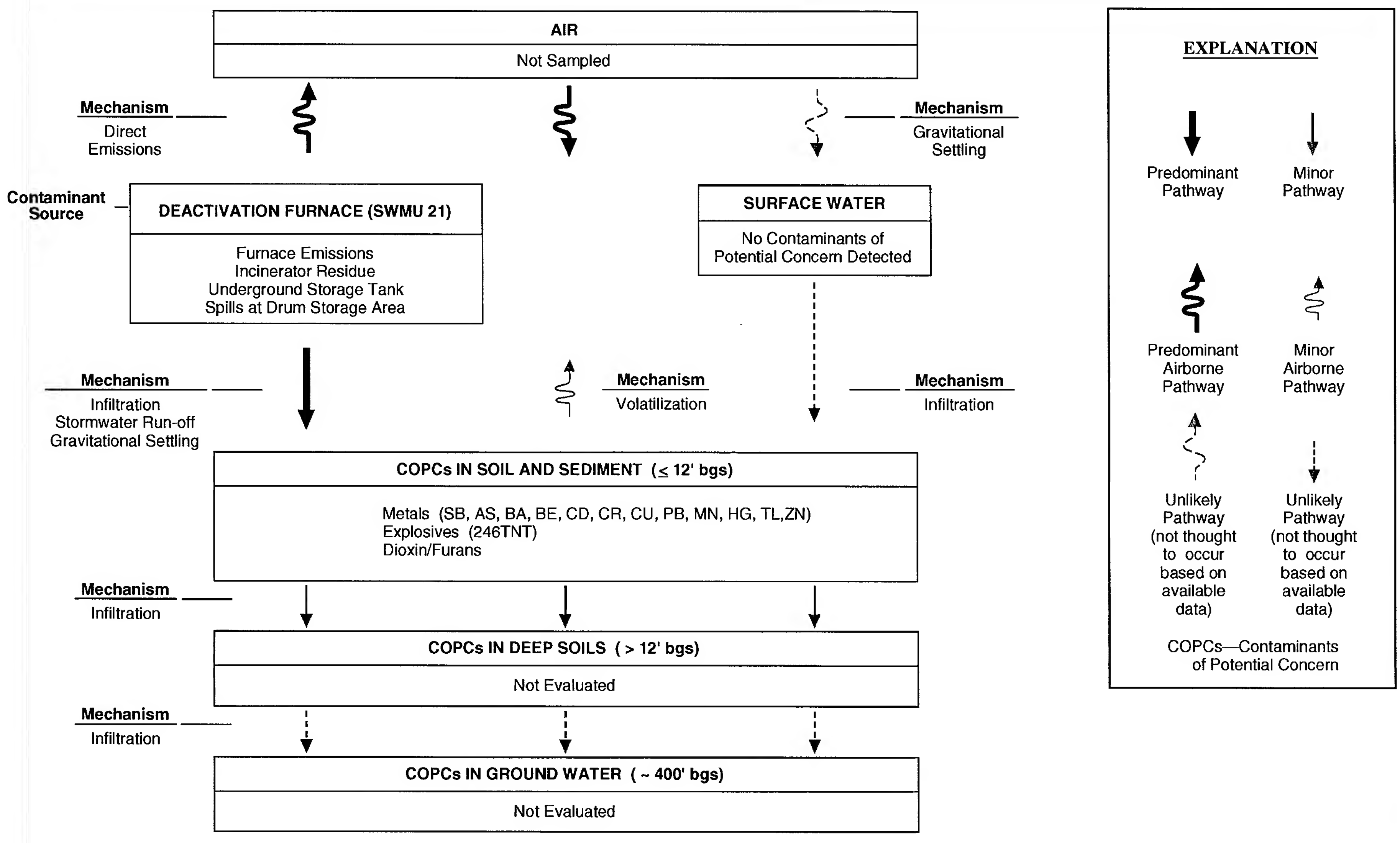

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
DEACTIVATION FURNACE—SWMU 21
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 10-5

soils, neutral to slightly basic pH soils, and depth to groundwater of more than 400 feet bgs. Because there is a continual flow of water out of the watering trough located about 125 feet east of Building 1320, a potential driving mechanism for contaminant transport does exist in this area. However, the metals detected in sediment (saturated soil) samples are at concentrations only slightly elevated above background. At these concentrations, and because of the alkaline soil conditions, it is not expected that the contaminants in the wet areas would be transported to groundwater. Because the sediment samples were also collected in the direction of surface water runoff and have metals concentrations much lower than those observed closer to the source areas, it would appear that off-site migration of metal contaminants via surface-water pathway has only a minimal effect on contaminant transport. The metal contaminants at the surface may provide particulates to the air pathway at this site.

10.3.4.4. Fate and Transport of Explosives. Explosive compounds in the environment are generally mobile and tend to leach and slowly volatilize from soils. With the exception of the sample obtained from the previous drum storage area (SS-21-005), the concentrations of explosives at SWMU 21 are low to non-detectable. This would suggest that the potential for leaching more than a few feet into the soil horizon would be minimal. Vadose zone contaminant transport modeling (RUST E&I, 1994) has shown that it would take over 100 years for these compounds to migrate 300 vertical feet and the resulting concentrations at these depths would be orders of magnitude less than the current concentrations in the soil. At SWMU 21, attenuation of the explosive concentrations would be expected through slow volatilization to the atmosphere and by slow photolytic transformations at the surface and by slow biodegradation in the subsurface.

10.3.4.5. Fate and Transport of Dioxins and Furans. Because dioxins and furans strongly adsorb to soil and sediment, they are immobile in most soils and are not likely to leach to groundwater or even to soil horizons that are deeper than a few feet bgs. Surface water runoff will have only a limited transport effect because of the low precipitation rates in this area and because dioxins and furans have only been detected in close proximity to source areas. Dioxins and furans are expected to be persistent in the environment; however, and may provide particulates to the air pathway.

10.4 HUMAN HEALTH RISK ASSESSMENT

10.4.0.1. The methods used to estimate the risks associated with SWMU 21 are given in Human Risk Assessment Methodology, Section 3.2.6. The COPCs were identified in the

previous section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 21) are presented in the following sections.

10.4.1. Exposure Pathways and Receptors

10.4.1.1. The pathways quantitatively evaluated in the BRA are: (1) those that are complete or likely to be completed in the future, and (2) those that may potentially cause a significant risk. An evaluation of completeness is shown on an exposure pathways diagram for SWMU 21 (Figure 10-6). An evaluation of pathway completeness and an assessment of whether a pathway is significant enough to require further evaluation for current and future receptors at SWMU 21 are given in Tables 10-2 and 10-3, respectively.

10.4.1.2. The civilian Depot personnel who operate the furnace at SWMU 21 are the current on-Depot receptors. This facility is not being used on a regular basis. If it were being used at capacity, one surveillance person and four to five workers would load munitions into a furnace kiln year-round for 10 hours per day for four days per week. Additional receptors include millwrights and ammunition directorate personnel that may be on site two days per month for 10 hours. Because the activities of furnace workers are limited to the building and asphalt-paved staging area, the workers are generally not in direct contact with the soil, but they may have incidental ingestion, dermal, and inhalation exposure, primarily via dust. Furnace workers are not exposed to potential contaminants in the surface water and sediment at the stock watering trough because they do not have any direct contact with these media, and incidental contact is unlikely.

10.4.1.3. Potential future on-Depot receptors for contaminants originating from SWMU 21 include construction workers and TEAD-N residents. Construction workers may be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For construction workers, direct exposure results from the anticipated excavation activities associated with construction or demolition of a building, and includes both surface and subsurface soil. Should this portion of the Depot be closed in the future (it is not slated for closure at this time) and the area be developed for residential use, residents could become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. It should be noted that a residential development is unlikely even if the Depot is closed because SWMU 21 is in a remote area. However, because of the requirements of UAC 315-101 (1994), a residential scenario was evaluated.

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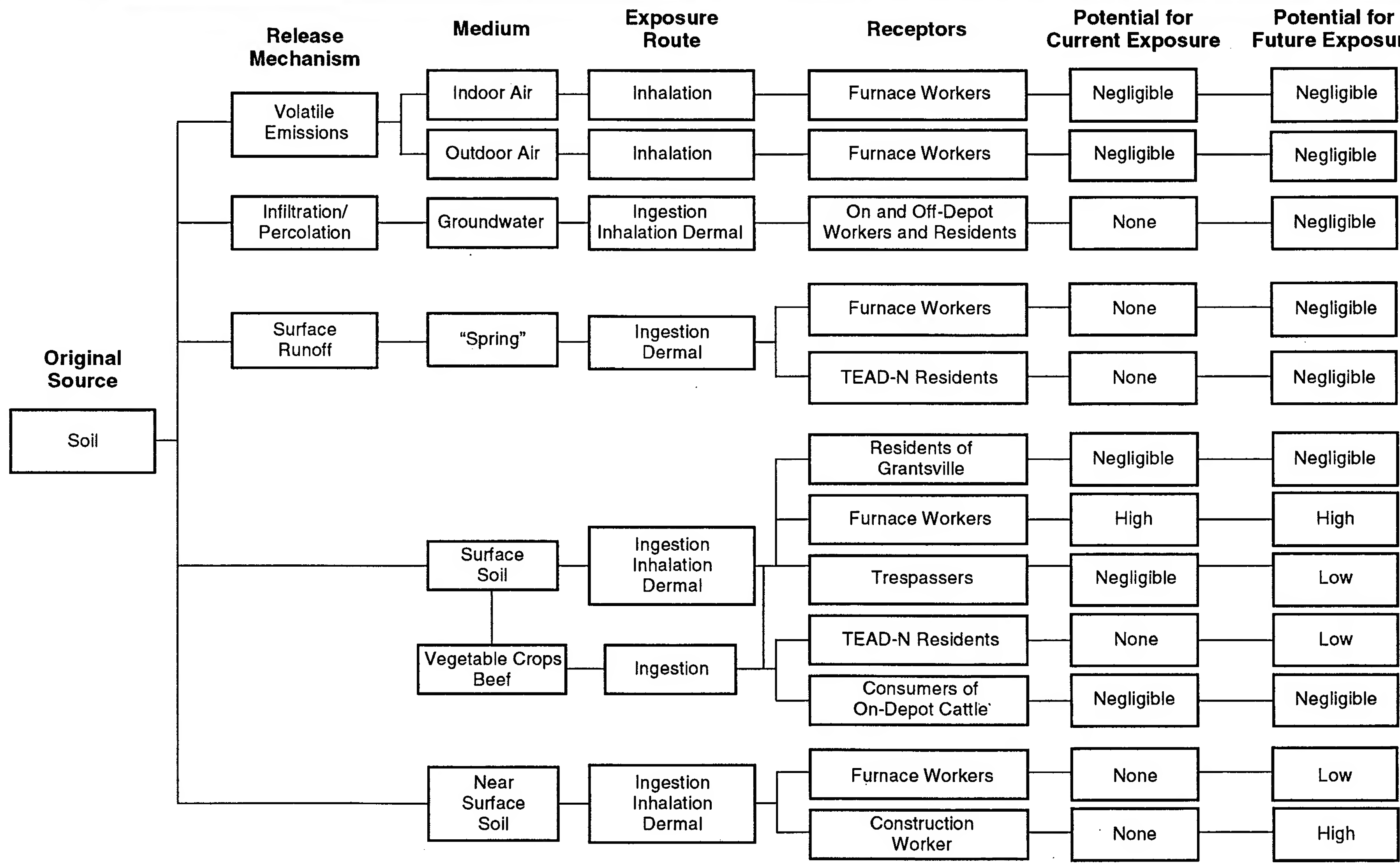


MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
DEACTIVATION FURNACE BUILDING—SWMU 21
EXPOSURE PATHWAYS DIAGRAM
FIGURE 10-6

TABLE 10-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 21: DEACTIVATION FURNACE BUILDING

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot Workers and Residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is approximately 320 feet below the below ground surface and evapotranspiration is high, and primary contaminants (i.e. metals) have low mobility.
Surface Water and Sediment	Depot Furnace Workers	Incidental ingestion and dermal contact with water or sediment	No. Depot personnel do not come into contact with surface water or sediment.
	Off-Depot Consumers	Consumption of beef from cattle that drink from the trough	No. Water is not contaminated.
Soil Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 21 is small and the amount of dust in Grantsville originating from SWMU 21 will be minuscule.
	Depot Furnace Workers	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil is contaminated. Fugitive dust is likely.
Near-Surface Soil	Depot Furnace Workers	Incidental ingestion of dust, inhalation, and dermal contact	No. Personnel activity patterns do not include intrusive activities such as excavation.
Air	Depot Furnace Workers	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure evaluated under soil.

TABLE 10-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 21: DEACTIVATION FURNACE BUILDING

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	Future TEAD-N Residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely in the future. Groundwater is 320 feet below the below ground surface, evapotranspiration is high, and primary contaminants (i.e. metals) have low mobility.
Surface Water and Sediment	Depot Furnace Workers	Incidental ingestion and dermal contact with water or sediment	No. Water and sediment are not contaminated.
	Off-Depot Consumers	Consumption of beef from cattle that drink from the spring	No. Water and sediment are not contaminated.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 21 is small and the amount of dust in Grantsville originating from SWMU 21 will be minuscule.
	Future TEAD-N Residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil is contaminated and while future residential land use is not expected, it cannot be ruled out.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Depot Furnace Workers	Incidental ingestion of dust, inhalation, and dermal contact	No. Exposure will be the same as that evaluated under current conditions.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers are unlikely and exposures will be less than current workers.
Near-Surface Soil	Construction Workers	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Near-surface soil is contaminated and future construction work is possible.
Air	Depot Furnace Workers	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure evaluated under soil.

TEAD-N Tooele Army Depot North Area

10.4.1.4. SWMU 21 could be converted into an area where crops are grown. However, efforts to grow vegetables in soil from adjacent areas failed (Rust E&I, 1995). The experiments included soil from an area where there was no known release of hazardous chemicals. It was concluded that the salt content of the soil was "toxic", and that vegetables could not be grown without leaching salt from the soil. Although such activities are considered unlikely, this pathway is evaluated as part of the future residential scenario.

10.4.1.5. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. This pathway is also evaluated as part of the future residential scenario.

10.4.1.6. For the pathways that were quantitatively evaluated (see Tables 10-2 and 10-3), site specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are presented in Appendix K.

10.4.2. Risk Characterization

10.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 21. The methods for calculating the risks are given in Section 3.2.6., and the SWMU-specific parameters used in the risk calculations are given in Appendix K.

10.4.2.2. Two aspects of the calculations deserve further discussion here. First, four were analyzed for hexavalent chromium (CrVI) and total chromium, and CrVI was detected in only one sample. Two of the samples had total chromium concentrations at or near background concentrations, from which one cannot discern the percentage of CrVI, which would be present only as a contaminant. The other two samples had total chromium concentrations of 57.6 (sample SS-21-012) and 52.4 mg/kg (sample SS-21-013). Hexavalent chromium was detected at a concentration of 0.853 mg/kg in only SS-21-013. Subtracting the threshold background concentration of 17.1 mg/kg from the total chromium concentration in this sample, CrVI was estimated to be present as 2.4 percent of the total chromium concentration in this sample. This is a conservative

estimate because (1) the threshold background concentration for chromium is at the upper end of the range of background levels; subtracting a smaller background level would decrease the percentage of the hexavalent chromium, and (2) a duplicate sample had approximately the same concentration of CrVI, but three times as much total chromium. Using this pair of results would lower the estimate of the percentage of CrVI. Assuming CrVI was present at the detection limit in SS-21-012 would also indicate that CrVI makes up less than 2.4 percent of the total chromium present in soil. However, because there are only two samples with which to base the percentage of chromium present as CrVI, there is a low confidence in the estimate. In this risk assessment, CrVI was conservatively assumed to be present at five percent of the total chromium concentration at SWMU 21.

10.4.2.3. The second aspect of the risk estimates requiring further discussion is the data from SS-21-005, which was not used. This sample consisted of stained soil from a previous drum staging area, and it contained concentrations of total chromium, 2,4,6-TNT, and 1,3,5-TNB more than two orders of magnitude higher than any other samples from SWMU 21. The stained soil has since been removed, so data from this sample are not necessarily representative of current conditions; however, confirmation samples were not collected after removal of the soil. While the risk estimates presume that the removal reduced COPC concentrations in this area to levels comparable to the rest of the SWMU, this assumption has not been verified.

10.4.2.4. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable, a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these two values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects may be possible. Adult blood lead levels between 10 and 15 micrograms per deciliter (μg/dl) is a benchmark range based on hypertension in adult males and transfer of lead from a pregnant mother to her fetus. For children, 10 μg/dl is the benchmark typically used by the EPA (USEPA, 1994; see Section 3.2.6. for a discussion of the calculation of blood lead concentrations for adults and children).

10.4.2.5. In addition to the calculated estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk

estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for current furnace workers, potential future construction workers, and potential future TEAD-N residents.

10.4.2.6. Furnace Workers. As shown on Table 10-4, the excess lifetime cancer risk for furnace workers at SWMU 21 was estimated to equal 1 x 10^{-5}. The cancer risk is dominated by inhalation of cadmium and ingestion of arsenic in soil. The significance of the risk estimates is increased because they apply to an exposure scenario that could readily happen, and by the fact that arsenic is classified as a Class A (known human) carcinogen. However, a more realistic estimate of the risk may be closer to 1 x 10^{-6} due to probable overestimates of the exposure duration, the exposure point concentrations, the soil ingestion rate, and the concentration of contaminated dust in the air. See the discussion of uncertainties in Section 10.4.3 for an elaboration of these factors.

10.4.2.7. The total hazard index for furnace workers was estimated to equal 3, and is largely based on dermal exposure to antimony, and the ingestion of antimony, cadmium, and thallium, and inhalation of dust containing barium and manganese. However, with the exception of the exposure duration (which does not affect the hazard index), all of the uncertainties applicable to the cancer risk are applicable to the hazard index. Therefore, the hazard index is probably an overestimate. While the inhalation pathway was not quantitatively evaluated for the COPCs other than barium and manganese due to the absence of inhalation reference doses, the exposure doses are low enough for the other COPCs that only a low potential for toxic effects is expected (see the discussion of uncertainties in Section 10.4.3.).

10.4.2.8. The blood lead level was estimated to be 35 µg/dl in five percent of workers. Because the current workers are present on an intermittent basis, this estimate is not applicable to them. However, if the Deactivation Furnace was operated on a full-time basis, there would be a concern that the workers could have blood lead levels high enough to cause adverse health effects. The risk estimates and qualitative factors modifying these estimates are summarized in Table 10-5.

10.4.2.9. Potential Future Construction Worker. The excess lifetime cancer risk for potential future construction workers was estimated to be 6 x 10^{-6} (Table 10-6). Inhalation of cadmium in dust dominated the risk. The significance of this estimate is

TABLE 10-4

SWMU 21 - DEACTIVATION FURNACE BUILDING
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FURNACE WORKERS

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.74E+01	5E-06	2E-07	5E-07	6E-06	44
Beryllium	1.63E+00	1E-06	1E-06	2E-08	2E-06	16
Cadmium	4.11E+02	NC	NC	5E-06	5E-06	32
Chromium(VI)	6.40E+00	NC	NC	5E-07	5E-07	3
Dioxins/Furans	9.13E-06	2E-07	4E-07	2E-09	6E-07	4
2,4,6-Trinitrotoluene	9.00E-01	5E-09	8E-09	NC	1E-08	<1
Pathway Total		7E-06	2E-06	5E-06		
Percent of Total		49	12	39		
			Total Cancer Risk:		**1E-05**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	3.04E+02	4E-01	2E+00	NC	2E+00	61
Arsenic	1.74E+01	3E-02	1E-03	NC	3E-02	<1
Barium	5.44E+03	4E-02	3E-02	2E-01	3E-01	8
Beryllium	1.63E+00	2E-04	1E-04	NC	3E-04	<1
Cadmium	4.11E+02	2E-01	1E-01	NC	3E-01	10
Chromium(VI)	6.40E+00	6E-04	2E-04	NC	9E-04	<1
Chromium(III)	1.22E+02	6E-05	6E-05	NC	1E-04	<1
Lead	2.50E+04	NC	NC	NC	NC	NC
Manganese	8.69E+02	3E-03	4E-03	3E-01	3E-01	9
Mercury	6.40E-02	1E-04	3E-05	4E-06	1E-04	<1
Thallium	4.63E+01	3E-01	1E-02	NC	3E-01	9
Zinc	1.10E+04	2E-02	3E-03	NC	2E-02	<1
2,4,6-Trinitrotoluene	9.00E-01	9E-04	1E-03	NC	2E-03	<1
Pathway Total		9E-01	2E+00	5E-01		
Percent of Total		29	55	15		
			Total Hazard Index:		**3E+00**	
		Blood Lead Concentration µg/dl (95th percentile):			**35**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 10-5

TEAD-N BASELINE RISK ASSESSMENT
SWMU 21–DEACTIVATION FURNACE BUILDING PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (μg/dl)	Key Chemicals[a]
Furnace Workers					35	
Ingestion	Current likely	Medium/High	0.9	7×10^{-6}		Antimony, arsenic, beryllium, cadmium, lead, manganese
Dermal	Current likely	Medium/High	2	2×10^{-6}		
Inhalation	Current likely	High/High	0.5	5×10^{-6}		
Construction Worker					55	
Ingestion	Future likely	Medium/High	3	1×10^{-6}		Antimony, arsenic, cadmium, lead, manganese
Dermal	Future likely	Medium/High	2	2×10^{-8}		
Inhalation	Future likely	High/High	6	4×10^{-6}		
TEAD-N Resident					77	
Ingestion	Future unlikely	High/High	20	6×10^{-5}		Antimony, arsenic, cadmium, lead, 2,4,6-trinitrotoluene
Dermal	Future unlikely	High/High	7	5×10^{-6}		
Inhalation	Future unlikely	High/High	3	2×10^{-5}		
Vegetable Crops	Future unlikely	High/Neutral	300	5×10^{-4}		
Beef	Future moderate	High/Neutral	0.001	2×10^{-9}		

TEAD-N Tooele Army Depot North Area

(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

TABLE 10-6

SWMU 21 - DEACTIVATION FURNACE
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.74E+01	1E-06	9E-09	4E-07	1E-06	25
Beryllium	1.63E+00	2E-07	4E-08	2E-08	3E-07	5
Cadmium	4.11E+02	NC	NC	4E-06	4E-06	63
Chromium(VI)	6.40E+00	NC	NC	4E-07	4E-07	6
Dioxins/Furans	9.13E-06	5E-08	1E-08	2E-09	6E-08	1
2,4,6-Trinitrotoluene	9.00E-01	9E-10	3E-10	NC	1E-09	<1
Pathway Total		1E-06	7E-08	4E-06		
Percent of Total		23	1	76		
			Total Cancer Risk:		**6E-06**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	3.04E+02	2E+00	2E+00	NC	3E+00	30
Arsenic	1.74E+01	1E-01	1E-03	NC	1E-01	1
Barium	5.44E+03	2E-01	3E-02	4E-01	6E-01	5
Beryllium	1.63E+00	8E-04	1E-04	NC	9E-04	<1
Cadmium	4.11E+02	1E+00	1E-01	NC	1E+00	10
Chromium(VI)	6.40E+00	8E-04	6E-05	NC	8E-04	<1
Chromium(III)	1.22E+02	3E-04	6E-05	NC	3E-04	<1
Lead	2.50E+04	NC	NC	NC	NC	NC
Manganese	8.69E+02	1E-02	4E-03	6E+00	6E+00	52
Mercury	6.40E-02	5E-04	3E-05	7E-05	6E-04	<1
Thallium	4.63E+01	1E-01	1E-03	NC	1E-01	1
Zinc	1.10E+04	9E-02	3E-03	NC	9E-02	<1
2,4,6-Trinitrotoluene	9.00E-01	4E-03	1E-03	NC	6E-03	<1
Pathway Total		3E+00	2E+00	6E+00		
Percent of Total		29	15	55		
			Total Hazard Index:		**1E+01**	
		Blood Lead Concentration µg/dl (95th percentile):			55	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

increased due to the likelihood of this pathway being completed in the future. However, because of likely overestimates of the exposure point concentration and the concentration of contaminated dust in the air, the cancer risk may well be close to or below 1 x 10^{-6}. This conclusion would be changed only if the construction work generated dust concentrations around 1 mg/m^3, as the remaining uncertainties are unlikely to be overestimates by a factor of six.

10.4.2.10. A hazard index of 10 was estimated primarily from the inhalation of manganese, the ingestion of cadmium, and dermal and ingestion exposure to antimony in soil. The calculations do not necessarily indicate a potential for adverse health effects, due to the conservative exposure assumptions. However, COPCs not included in the hazard index due to lack of inhalation references doses could pose a risk. The inhalation exposure doses of chromium, cadmium, and zinc are high enough that there may be a potential for adverse health effects (see the discussion of uncertainties in Section 10.4.3. and a summary of exposure doses in Appendix K).

10.4.2.11. The low potential for adverse effects from quantified exposures is based on the expectation of overestimates of exposure via ingestion and inhalation. The ingestion hazard index of 3 (Table 10-6) is likely to be less than 1 based on an overestimate of the soil ingestion rate by a factor of 3.5 (Section 5.4.3.), less than 100 percent bioavailability of the contaminants, and overestimates of the exposure point concentrations due to judgmental sampling. The dermal hazard index of 2 is likely biased high by a factor of 4 due to the soil adherence factor. The inhalation hazard index of 6 was derived from the presence of manganese, for which the upper bound estimate of the average concentration was 870 mg/kg. However, the average concentrations of manganese in soil in the western United States is 380 mg/kg (Shacklette and Boerngen, 1984). Because the hazard index is directly proportional to the COPC concentration, a construction worker in the western United States would have a hazard index of over two. In other words, based on the risk estimate for SWMU 21, all construction workers in the western U.S. are at risk from exposure to manganese. Therefore, we expect that either the toxicity, exposure parameters, or both have been significantly overestimated, and there is a minimal manganese hazard for a construction worker at SWMU 21.

10.4.2.12. One percent of construction workers were estimated to have blood lead concentrations of over 50 µg/dl. Health effects have been documented in adults at this blood lead concentration. While the biokinetics of lead are complex and lead to uncertainties in the model, it is expected that the estimated blood lead concentration

would still be above the 10 to 15 μg/dl benchmark range after these uncertainties were accounted for.

10.4.2.13. Potential Future TEAD-N Resident. For SWMU 21, the cancer risk from all exposure pathways was estimated to equal 5 x 10^{-4}, and the hazard index was estimated to equal 300. As shown on Table 10-7, the excess lifetime cancer risk for potential future residents exposed to soil at SWMU 21 was estimated to equal 8 x 10^{-5}. The cancer risk is dominated by ingestion of arsenic and beryllium and inhalation of cadmium. Over half of the cancer risk was due to the presence of arsenic, but arsenic was present at background levels (10 mg/kg) in most samples. The background threshold was exceeded in two of ten samples with concentrations of 11 mg/kg and 43 mg/kg. Consequently, arsenic is present at elevated concentrations in only localized areas of the SWMU. As has been explained for other SWMUs, exposure estimates are likely to be high because much of the area would be paved or covered with grass in a residential setting, although the cancer risk from potential exposure to soil might still exceed 1 x 10^{-6} if the pathway was completed. However, because residents are unlikely to live at what is now SWMU 21, the significance of the risk estimate is diminished.

10.4.2.14. The total hazard index for potential future child residents exposed to soil was estimated to equal 30 and the blood lead concentration was estimated to equal 77 μg/dl. The hazard index is primarily derived from the ingestion of antimony, cadmium, and thallium, dermal exposure to antimony, and inhalation of barium and manganese. The blood lead level is indicative of a clear potential for health effects to occur in children should this pathway (although unlikely) be completed.

10.4.2.15. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 21, the estimated cancer risk is 4 x 10^{-4} and the hazard index is 300 (Table 10-7), primarily due to 2,4,6-TNT, arsenic, antimony, and cadmium. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has several orders of magnitude of uncertainty because of uncertainties in the plant uptake factors (see Section 10.4.3.). If plants metabolize explosives (this process has not been accounted for in the plant uptake modeling), the risks from explosives via this pathway would be low. Because of the high degree of uncertainty, the significance of these risk estimates is unknown.

10.4.2.16. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 21, the estimated cancer risk is 2 x 10^{-9} and the hazard index is 0.001 (Table 10-7). This scenario primarily applies to ranchers that may slaughter cattle

TABLE 10-7

SWMU 21 - DEACTIVATION FURNACE
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.74E+01	5E-05	7E-07	1E-06	1E-04	4E-10	2E-04	31
Beryllium	1.63E+00	1E-05	3E-06	7E-08	6E-06	6E-11	2E-05	4
Cadmium	4.11E+02	NC	NC	1E-05	NC	NC	1E-05	3
Chromium (VI)	6.40E+00	NC	NC	1E-06	NC	NC	1E-06	<1
Dioxins/Furans	9.13E-06	2E-06	1E-06	7E-09	2E-05	1E-09	2E-05	4
2,4,6-Trinitrotoluene	9.00E-01	4E-08	2E-08	NC	3E-04	8E-15	3E-04	58
Pathway Total		6E-05	5E-06	2E-05	4E-04	2E-09		
Percent of Total		13	<1	3	83	<1		
					Total Cancer Risk:		**5E-04**	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	3.04E+02	1E+01	6E+00	NC	7E+01	6E-05	8E+01	26
Arsenic	1.74E+01	7E-01	5E-03	NC	1E+00	4E-06	2E+00	<1
Barium	5.44E+03	1E+00	1E-01	2E+00	5E+00	8E-07	8E+00	2
Beryllium	1.63E+00	4E-03	6E-04	NC	1E-03	2E-08	6E-03	<1
Cadmium	4.11E+02	5E+00	5E-01	NC	1E+02	9E-06	1E+02	36
Chromium (VI)	6.40E+00	2E-02	1E-03	NC	6E-03	1E-07	2E-02	<1
Chromium (III)	1.22E+02	2E-03	3E-04	NC	5E-04	1E-08	2E-03	<1
Lead	2.50E+04	NC	NC	NC	NC	NC	NC	NC
Manganese	8.69E+02	8E-02	2E-02	2E+00	7E-01	2E-07	3E+00	<1
Mercury	6.40E-02	3E-03	1E-04	2E-05	9E-03	5E-09	1E-02	<1
Thallium	4.63E+01	7E+00	5E-02	NC	1E+00	1E-03	8E+00	3
Zinc	1.10E+04	5E-01	1E-02	NC	NC	2E-04	5E-01	<1
2,4,6-Trinitrotoluene	9.00E-01	2E-02	6E-03	NC	1E+02	3E-09	1E+02	32
Pathway Total		2E+01	7E+00	3E+00	3E+02	1E-03		
Percent of Total		8	2	1	89	<1		
					Total Hazard Index:		**3E+02**	

Blood Lead Concentration µg/dl (95th percentile): 77

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure
TEAD-N Tooele Army Depot North Area

for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 21 if they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

10.4.3. Uncertainties

10.4.3.1. The exposure estimates and toxicity values have associated uncertainties, the magnitude and nature of which affect the confidence that can be placed in the results. Most of the uncertainties are such that risk estimates could be lower, but are unlikely to be higher than estimated. The following paragraphs discuss uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor. These discussions are focused on elements contributing most to overestimates of the total risk, and on those elements where risks may be underestimates. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk.

10.4.3.2. Sampling at SWMU 21 included judgmental samples from areas where stained soil was observed and areas likely to have received spills and surface runoff. Consequently, the exposure point concentrations are upper bound estimates from a data set that included sampling locations likely to have the highest COPC concentrations. Therefore, the exposure point concentrations should be higher than the average concentrations of the contaminants. A possible, but unlikely, exception is if COPC concentrations in the Previous Drum Staging Area were not greatly reduced by the removal of stained soil.

10.4.3.3. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having

additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

10.4.3.4. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical (tetraethyl lead) with a reference dose below 1×10^{-6} mg/kg/day and, therefore, this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation of metals with exposure doses greater than 1×10^{-6} was examined on a case-by-case basis. The results of this evaluation were presented in Section 10.4.2. Exposure doses are summarized in Appendix K.

10.4.3.5. Furnace Workers. One factor affecting the cancer risk estimates for the furnace worker is the assumption that exposure will take place over a 25-year period. Most people change jobs, or their job location, more frequently. The resulting cancer risk would be reduced according to how long a person is actually at the contaminated job location.

10.4.3.6. The greatest uncertainty related to inhalation exposure is the assumed dust level of 50 $\mu g/m^3$, which is the National Ambient Air Quality Standard for respirable dust. Dust concentrations measured during the field program sometimes greatly exceeded 50 $\mu g/m^3$, although concentrations were lower on most days. Because SWMU 21 is small, only a small fraction of the dust will originate within the SWMU. Using a value of 50 $\mu g/m^3$ will overestimate the resulting inhalation exposure.

10.4.3.7. Uncertainties related to ingestion exposure are derived primarily from the soil ingestion rate. A typical ingestion rate for adults is probably closer to 25 mg/day (DTSC, 1992), rather than the 50 mg/day assumed in this risk assessment. Also, while soil contaminants were assumed to be 100 percent bioavailable, the actual bioavailability may be substantially less. The most important uncertainties related to dermal exposure of metals are the dermal and oral absorption factors. Metals are typically thought to be

poorly absorbed through the skin (USEPA, 1992). However, metals poorly absorbed through the oral route (such as antimony, for which only one percent is thought to be absorbed into the bloodstream) will have increased risks calculated by the dermal exposure route. Other factors, including 1) a soil adherence factor that likely is valid for only the front of the hands (i.e., the palms) and is probably an overestimate by a factor of five for the rest of the body; and 2) the low potential for all exposed skin to be covered in soil, tend to overestimate the potential for dermal exposure. Dermal exposure uncertainties have less effect on the risk estimates for the two COPCs that are organic compounds (dioxins and 2,4,6-TNT). Dermal exposure has been well studied in dioxins so there is less uncertainty for this class of compounds, and 2,4,6-TNT would not generate a risk even if it was assumed to be 100 percent absorbed so the dermal uncertainties are not critical for these compounds.

10.4.3.8. Construction Worker. Uncertainties associated with the exposure dose for a construction worker are high. While construction workers are typically exposed to contaminants in surface and subsurface soil, no subsurface samples were collected at SWMU 21. Surface concentrations are expected to be higher than subsurface concentrations, but the magnitude of the overestimate is difficult to predict.

10.4.3.9. As discussed for SWMU 1 (Section 5.4.3.), a reasonable ingestion rate is probably a factor of 3.5 less than the 480 mg/day used in this risk assessment. Also, the bioavailability of the contaminants in the soil is likely to be less than 100 percent assumed for the BRA, further reducing the actual dose and corresponding risk. As with the furnace worker, uncertainties related to inhalation exposure are primarily associated with the dust concentration generated by construction activities. As discussed in relation to SWMU 20, if a construction project generates dust levels on the order of 1 mg/m^3, the dust levels assumed in this BRA are reasonable. However, if the main source of dust is the wind, then the concentration of contaminated dust is a large overestimate. Uncertainties in the dermal pathway are similar to those for the furnace worker.

10.4.3.10. TEAD-N Residents. The uncertainties for construction and furnace workers are also uncertainties in the evaluation of future residents at TEAD-N, although the magnitude of the uncertainties differ. In a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure and (to a lesser extent) reduces the potential for dermal and ingestion exposure. As in the case of the workers, uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the dust level. The EPA default

ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who directly eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate may exceed the assumed rate of 200 mg/day. However, the realistic potential for residential use must be taken into account in the risk management decision.

10.4.3.11. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

10.4.3.12. The plant uptake models are based on theoretical predictions with minimal validation. Because of the uncertainties summarized in the previous paragraph, uncertainties in the uptake of metals are expected to be about one to two orders of magnitude. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53. This has not been accounted for in the exposure calculations.

10.4.3.13. There is even greater uncertainty at SWMU 21. The estimated risks for the produce exposure pathway are dominated by 2,4,6-TNT. However, the equation used to estimate the plant uptake factors from the log K_{ow} was developed using mostly data for pesticides, which are very different from explosives; a poorer fit would be expected for explosives than for compounds used to develop the relationship. The plant uptake model also does not account for metabolism of the chemical by the plant. Based on its polar structure, it would not be surprising if plants metabolize 2,4,6-TNT, thus eliminating exposure to explosives by humans through this pathway. In addition, because the salt content of the soil is currently toxic to plants (see Section 10.4.1.4.), the soil would need to be diluted with peat or other soil amendments to grow produce. This has not been accounted for in the exposure calculations. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

10.4.4. Recommendations

10.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Monitor worker exposure to metals should facility operations increase from part-time to full-time, and take corrective action should exposure exceed occupational levels (note that operations are expected to continue at this facility indefinitely into the future).

- Prohibit work unless conducted in compliance with OSHA hazardous waste regulations (29CFR 1910.120). An exception is work which involves occupational exposure to lead, as lead in soil is not expected to cause an exceedence of the OSHA lead standard.

- Prohibit construction work unless conducted in compliance with OSHA hazardous waste regulations.

- Evaluate cleanup levels and the appropriate method of corrective action in a Corrective Measures Study.

10.5 ECOLOGICAL RISK ASSESSMENT

10.5.0.1. This section discusses the results of the Tier 1 and Tier 2 ecological evaluations. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors are presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4.

10.5.1. Tier 1

10.5.1.1. Ecological Receptors. The area inside the fence and isolated areas outside the fence have been physically disturbed by the industrial activities at SWMU 21. The disturbed areas support a variety of weedy species including gumweed, Russian thistle, cheatgrass, annual sunflower, and shepherd's purse. Big sagebrush, rubber rabbitbrush, gumweed, halogeton, red three-awn, and annual sunflower are commonly seen in the undisturbed areas outside the fence line of this site. A short distance away, Utah juniper trees are evident. The mapped range and soil type are:

Range Site: Semi-Desert Gravelly Loam

Soil Types: Berent-Hiko Peak, fine sand and gravelly loam with 2 to 15 percent slopes.

10.5.1.2. Expected Climax Vegetation. The range site describes the climax vegetation expected to occur at each site due to the combined influences of environmental factors characteristic for the site. The Wyoming big sagebrush is the dominant, and most conspicuous, plant species expected in this range site. Other dominant species in the semi-desert gravelly loam range site are bluebunch wheatgrass, Indian ricegrass, Douglas rabbitbrush, bottlebrush squirreltail and Hood phlox (USSCS, 1991). The Utah juniper is the most conspicuous tree in the semi-desert and sand range site that borders SWMU 21.

10.5.1.3. Wildlife. No reptiles were observed at SWMU 21 but, based on sightings elsewhere at the Depot, the collared and side-blotched lizard, the western whiptail, the Great Basin rattlesnake and the gopher snake may be inhabitants at or near SWMU 21.

10.5.1.4. Although no small mammals were observed at SWMU 21, abundant indicators of small mammal activity were observed in the undisturbed areas. The indicators consisted of tracks, active burrows, stem cuttings, diggings to bury seed, and rabbit pellets from black-tailed jackrabbit and desert cottontail. The common small mammal species that are probable inhabitants at SWMU 21, based on observations elsewhere at the Depot, include the valley pocket gopher, Ord's kangaroo rat, and the little pocket mouse (RUST, 1994). Other potential small mammal inhabitants, based on literature reviews, include the Great Basin pocket mouse, pinion mouse, sagebrush vole and the desert woodrat (Burt and Grossenheider, 1980). No large mammals were observed at SWMU 21. Likely large mammal species that visit SWMU 21 are coyotes, pronghorn antelope, and mule deer.

10.5.1.5. A red-tailed hawk was observed soaring near SWMU 21. Other raptors such as the golden eagle, American kestrel, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, red-tailed hawk, and the great-horned owl have been observed in other areas of TEAD-N. Because of the typical range of these species during foraging/hunting activities, raptors may be at SWMU 20 on an intermittent basis.

10.5.1.6. No passerine or other birds were observed during the site visit. The sage grouse, a State of Utah sensitive species, may inhabit the undisturbed areas of the

SWMU. Many other non-game birds, such as crows and several families of passerine birds, would be expected.

10.5.1.7. SWMU 21 is likely to attract highly mobile receptors on an intermittent basis because of the presence of artificially created surface water (Sec. 10.2.2.2.) in the semi-desert environment. Receptors with high mobility include birds and large mammals such as the deer and coyote. These receptors may use the surface water at SWMU 21 as a primary source of water and/or a hunting ground.

10.5.1.8. Results of the Tier 1 Ecological Assessment. The field surveys indicate that the vegetation at SWMU 21 has been impacted to a greater degree by the physical activities at the site (i.e., clearing and construction) than by the chemicals that may have been released there. The ecological assessment, therefore, addresses the potential adverse impact to the wildlife receptors and it is not deemed necessary to address the effects on the vegetation. The ecological assessment is performed with the assumption that the wildlife receptors are not limited by the physical boundaries of each SWMU; therefore, the spatial distribution of the detected chemicals at SWMU 21 is assumed to potentially expose the wildlife species that occur or that may potentially occur at the TEAD-N facility as a whole. The results of the Tier 1 assessment indicate that the detected levels of some of the chemicals at SWMU 21 warrant a Tier 2 evaluation.

10.5.2. Tier 2

10.5.2.1. The objective of the Tier 2 assessment is to further evaluate the Tier 1 COPECs by comparing the receptor's chemical exposure dose to a biological endpoint.

10.5.2.2. Exposure Analysis. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil; indirect exposure occurs via the food web, such as when a raptor consumes a mouse. The surface water was not evaluated as an aquatic ecosystem because the source of water is a well and the saturated area is artificial.

10.5.2.3. The reptiles potentially inhabiting SWMU 21 may be exposed via direct pathways (ingestion and dermal exposure to soil) and, to a lesser extent, via food web pathways (e.g. ingestion of contaminated insects). As prey, they may also expose predators.

10.5.2.4. The small mammals are exposed predominantly via direct pathways (ingestion of soil) and, to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators. Antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing or ingestion of the surface water) and, as prey, may expose predators. The coyote (a predator) is exposed predominantly via food web pathways.

10.5.2.5. The predominant route of exposure for the raptors is via food web pathways because they typically do not spend much time on the ground. The non-raptor birds are exposed via food web pathways by ingestion of seeds and grasses, and by direct exposure to soil during preening and ingestion of water.

10.5.2.6. Risk Characterization. The ecological risk characterization for the COPECs at SWMU 21 is based on the ecological toxicity quotient derived by comparing either the dose ingested by the indicator species, or the chemical concentration in the soil, to a biological endpoint. The ingestion pathway is associated with the greatest exposure at TEAD-N. The results of the ecological evaluation are presented in Appendix K. The results indicate that antimony, barium, cadmium, copper, cyanide, manganese, thallium, zinc, and lead are the COPECs at SWMU 21 that have ETQs greater than 1.0. These estimated ETQs, however, are overestimations due to the uncertainties in the evaluation. The calculations were done with the assumption that the foraging area of the receptors is exclusively within the contaminated area at SWMU 21. This conservative assumption leads to a contaminant intake or dose that is significantly higher than what is actually being ingested by the receptors.

10.5.2.7. When the foraging area exceeds the contaminated area, a correction factor that accounts for less than full-time exposure is required (deSesso, 1994). The mobility factor is a suggested method for estimating the fraction of time that a receptor may be exposed to a contaminant. The mobility factor is the ratio of the contaminated area to the foraging area and accounts for the effect of receptor mobility to the frequency and duration of exposure to the contaminated media. The areal extent of SWMU 21 is very small relative to the foraging area of the selected indicator species, thus significantly reducing the ETQs. Consequently, the potential for adverse impacts to the ecological receptors is diminished. The receptors that may have a high exposure are the less mobile receptors such as reptiles or small mammal species. The field surveys did not observe these species at SWMU 21, but the ecological assessment identifies them as possibly occurring at the site. The impact to less mobile terrestrial receptors at SWMU 21 is not significant

enough to adversely affect the structure and function of the ecosystem due to the limited number of individuals (based on the size of the SWMU) potentially affected.

10.5.2.8. In addition, the relatively low bioaccumulative potentials for the metals and explosives retained for quantitative analysis make the potential for impacts to higher predator trophic levels unlikely. It is, therefore, recommended that SWMU 21 be proposed for no further investigation into the potential for ecological effects.

10.5.2.9. Uncertainties. The evaluation does not take into account the frequency of exposure to the contaminant nor the effect of receptor mobility on the frequency and duration of contact with the contaminated media. The use of NOAEL-type values as surrogates for effective concentration is significantly more conservative as an indicator of risk.

10.5.3. Recommendations

10.5.3.1. Based on the preceding discussions, SWMU 21 is recommended for no further investigation regarding potential ecological effects.

11.0 PESTICIDE HANDLING AND STORAGE AREA (SWMU 34)

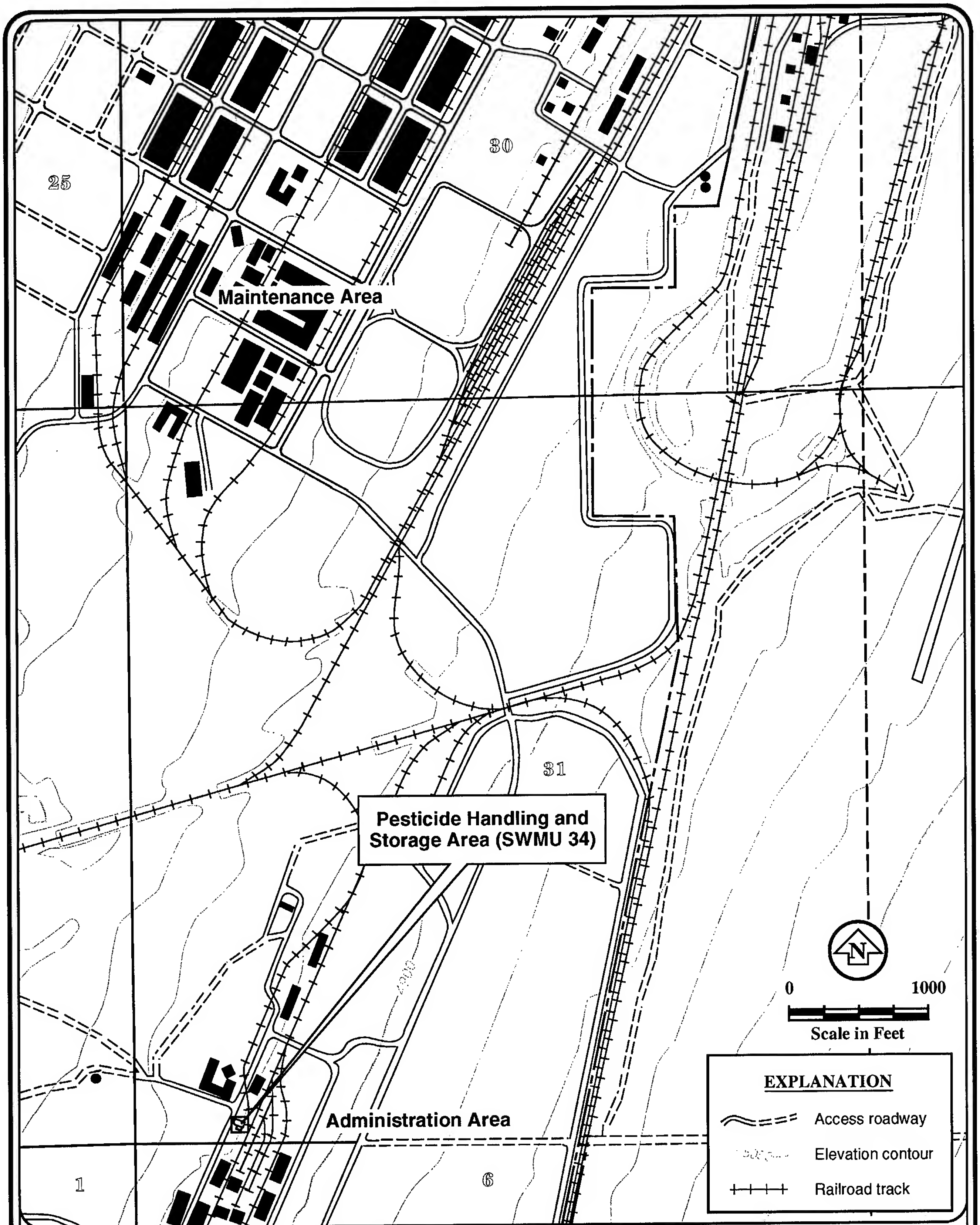
11.1. SITE BACKGROUND

11.1.0.1. Site Description. The Pesticide Handling and Storage Area is located in Building 518 in the Administration Area, in the southeastern portion of TEAD-N (Figure 11-1). This facility was used for storing and handling pesticides since about 1942 (Smith, 1990), but was recently closed. The building has bermed, sealed, concrete floors, and is constructed of flame retardant material. Pesticides, herbicides, and other materials are stored in separate, vented, locked rooms. The mixing/formulation area is located in the building but separated from the storage area by bermed concrete. The facility is vented and equipped with backflow prevention devices on the water lines which feed the facility. In recent years, a bermed concrete pad for loading sprayer trucks has been added to the south side of the building. This facility is labeled and secured with a chain-linked fence (Jordan, 1989). The area enclosed by the fence is about 75 feet by 75 feet in size, or about 0.13 acres. One small above-ground storage tank for heating oil is located along the north side of Building 518.

11.1.0.2. According to a preliminary assessment/site investigation (PA/SI) conducted by EA Engineering Science and Technology (EA), current practices at this building appear to meet AEHA guidelines and federal requirements (EA, 1988). The pesticides are stored in separate, vented locked rooms. Only certified pest control personnel handle the pesticides. Disposal of pesticide containers is conducted through a subcontractor at an off-depot treatment and disposal facility. On-site disposal of obsolete pesticides at TEAD-N ended in the early 1980s (EA, 1988). Prior to 1980, potentially hazardous pesticides were disposed of at the Pesticide Disposal Area (SWMU 12) in the Sanitary Landfill (SWMU 15).

11.1.0.3. Operational Activities. Activities associated with the building include storage and mixing/formulation of pesticides, filling tanks with pesticides, and rinsing containers. Pesticides and herbicides stored at this facility in the past included DDT, 2,4-D and Roundup (NUS, 1987).

11.1.0.4. Drains from the building originally discharged via an 8-inch diameter underground pipe to the Stormwater Discharge Area (SWMU 45) located approximately 4,000 feet northwest of the building (Smith, 1990). Investigation of SWMU 45 is included as a separate task in this RFI. Currently there are no discharges from the



Source: Modified from USGS Tooele 7.5 minute quadrangle.

TEAD-N RFI—GROUP A SWMUs
SWMU 34
PESTICIDE HANDLING AND STORAGE AREA
LOCATION MAP
FIGURE 11-1

MONTGOMERY WATSON

PROJECT NO. 2942.0190

Pesticide Handling and Storage Area. All drains have been blocked, and wash water is contained in a catch tank located on the north side of the building (Nichols, 1991).

11.1.0.5. A small outfall pipe extending through the berm in the batching and mixing area to the gravel surrounding the building was noted during a site visit by E. C. Jordan in the Fall of 1989 (Jordan, 1989). At that time, an unidentified liquid was observed at the mouth of the outfall pipe.

11.1.0.6. Geology and Hydrogeology. Soils beneath the Administration Area that contains the Pesticide Handling and Storage Area are composed of the silty and sandy gravels of the Abela Series (USSCS, 1991). The approximate depth to the regional water table is about 375 feet, and groundwater flows to the northwest (JMM, 1988). The depth of bedrock is approximately 1,300 feet bgs (ERTEC, 1982). Gravelly fill material has been imported to cover the surface soils that surround the facility.

11.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

11.2.1. Previous Investigations

11.2.1.1. No environmental sampling prior to the RFI activities has been conducted at the Pesticide Handling and Storage Area, so available analytical data are limited to those collected during the RFI. As previously mentioned, a preliminary assessment/site investigation was conducted by EA Engineering Science and Technology that reviewed the physical aspects of the facility and the materials handling practices (EA, 1988).

11.2.2. RFI Sampling Summary

11.2.2.1. Phase I Sampling. During Phase I RFI sampling, six surface soil samples were collected from beneath discharge pipes on the fuel storage tank, mixing sink catch-tank, concrete pad loading area, and other locations around the building. All samples were analyzed for pesticides, herbicides, cyanide, and metals.

11.2.2.2. Phase II Sampling. A total of 13 soil borings were drilled at and around the Pesticide Handling and Storage Area, both inside and outside the fenced compound during Phase II sampling. The following drilling and sampling activities were conducted:

- Seven 3-foot soil borings were drilled at locations around SWMU 34, and three soil samples collected from each (at the surface, 1.5 feet, and 3.0 feet bgs) for a total of 21 soil samples. All samples were analyzed for total metals and pesticides. These 3-foot borings were located up to 50 feet from the facility.

- Three 20-foot deep soil borings were drilled at locations adjacent to the outfall pipe, the mixing sink catch tank, and beneath the concrete spill basin, and five soil samples collected from each (15 samples total) to investigate vertical contaminant migration at areas where aqueous discharges may have occurred. The soil samples were collected at the surface and at depths of 5, 10, 15, and 20 feet bgs and submitted for total metals and organochlorine pesticides analyses. Five of these 15 samples were also submitted for BETX analysis based on PID or FID readings and soil appearance.

- One 3-foot soil boring was drilled adjacent to the aboveground heating oil tank, and three samples (from the surface, 1.5 feet and 3 feet bgs) submitted for TRPH analysis from this boring.

- Two 3-foot borings were drilled at locations distant from SWMU 34 activities, but within the same soil type, and two soil samples collected from each for background metals analysis (four samples total).

11.2.2.3. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that all of the SWMU 34 data are usable. Two soil samples were qualified by the USAEC chemistry branch due to organochlorine pesticide holding time exceedences of one and two days. Six soil samples were qualified as estimated for organochlorine pesticides by Montgomery Watson chemists due to MS/MSD nonconformances (and one for a holding time nonconformance). Additionally, one soil sample had selenium qualified as estimated due to MS/MSD nonconformances. However, no data for this SWMU were rejected; therefore, 100 percent completeness was achieved. Further details concerning the data review are presented in Appendix E of this document.

The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviation and DQOs were met. Due to this, no data

gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

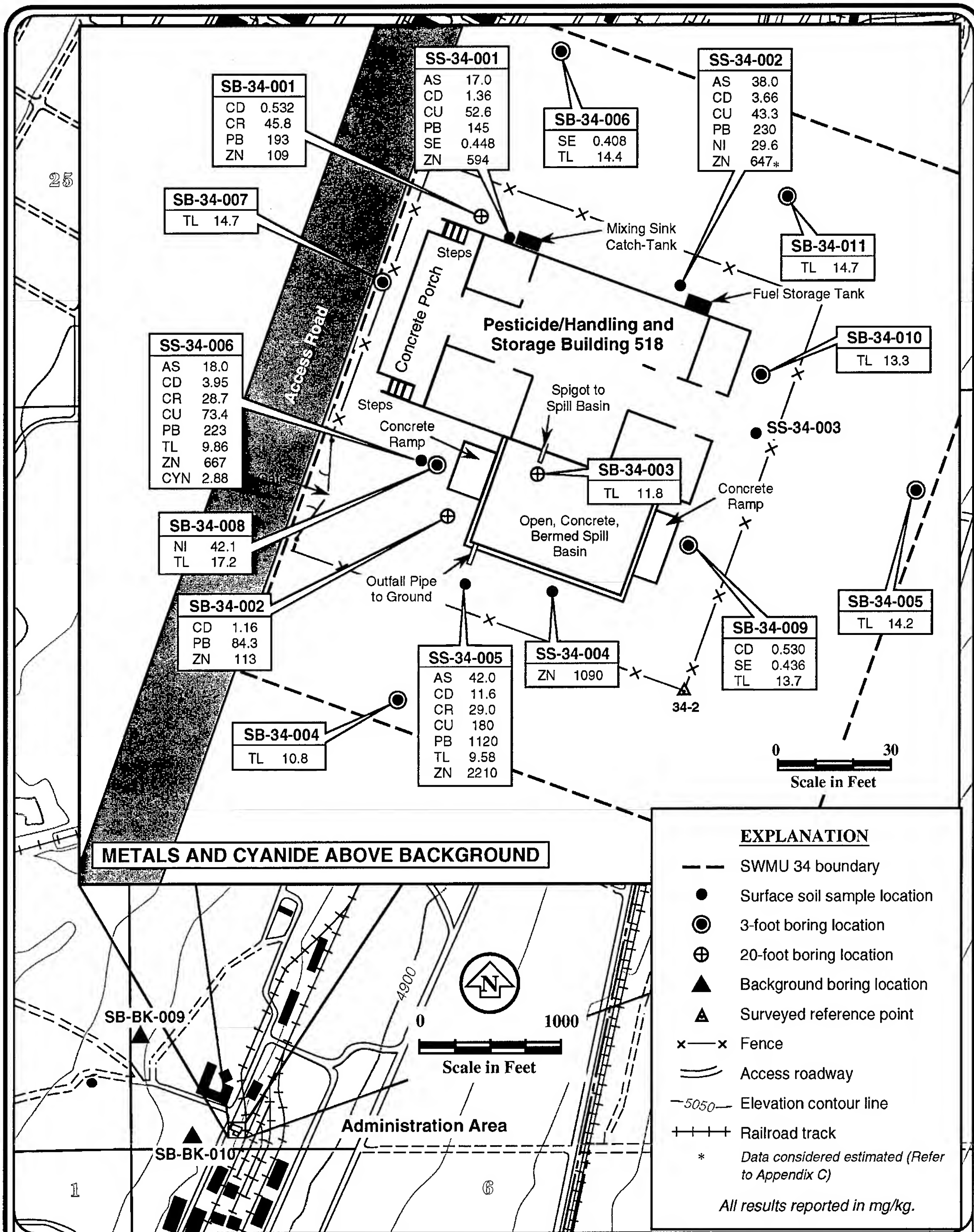
11.3 CONTAMINATION ASSESSMENT

11.3.1. RFI Sampling Results

11.3.1.1. Surface Soils. Contaminants detected in the surface soil samples included elevated metals, cyanide, pesticides, and one herbicide. As shown in Figure 11-2, elevated levels of several metals were detected in five of the six surface soil samples collected, and in the surface intervals of all eleven environmental boreholes. Cadmium, chromium, lead, zinc, and thallium were the most common metals detected. Cyanide was also detected in one of the surface soil samples at a concentration of 2.88 mg/kg. Comparisons of the surface metals results with available risk-based guidance thresholds for soil (USEPA, 1994a) show that all thallium detections exceeded the threshold for a residential scenario of 6.3 mg/kg (conservatively assuming that thallium is present as thallium chloride, which is bioavailable and the most toxic of the thallium salts). Eight of the borehole samples, all from surface intervals, and one of the six surface soil samples showed thallium concentrations above this value. The risk-based guidance threshold for thallium (as thallium chloride) in commercial/industrial soils of 82 mg/kg was not exceeded for any soil samples from SWMU 34.

11.3.1.2. Lead was detected up to 1120 mg/kg, and arsenic up to 42.0 mg/kg in the surface soils. The lead concentration in one sample exceeded the risk-based screening level of 400 mg/kg for residential soil, but was below the maximum industrial level of 5,000 mg/kg. The four samples in which arsenic was detected above background exceeded the available risk-based guidance threshold for a residential soil (USEPA, 1994a).

11.3.1.3. Pesticide compounds were detected in all of the surface soil samples and surface intervals of the boreholes (Figure 11-3). Compounds detected included the pesticides DDT, DDD, DDE, alpha- and gamma-chlordane, heptachlor, dieldrin, endrin, and lindane. The herbicide 2,4-D was also detected in one of the surface soil samples. For comparison purposes, the following summarize the detections of pesticides in the surface soils that exceed the available risk-based guidance thresholds for soil where they have been established (USEPA, 1994a).



Source: Modified from USGS Tooele 7.5 minute quadrangle.

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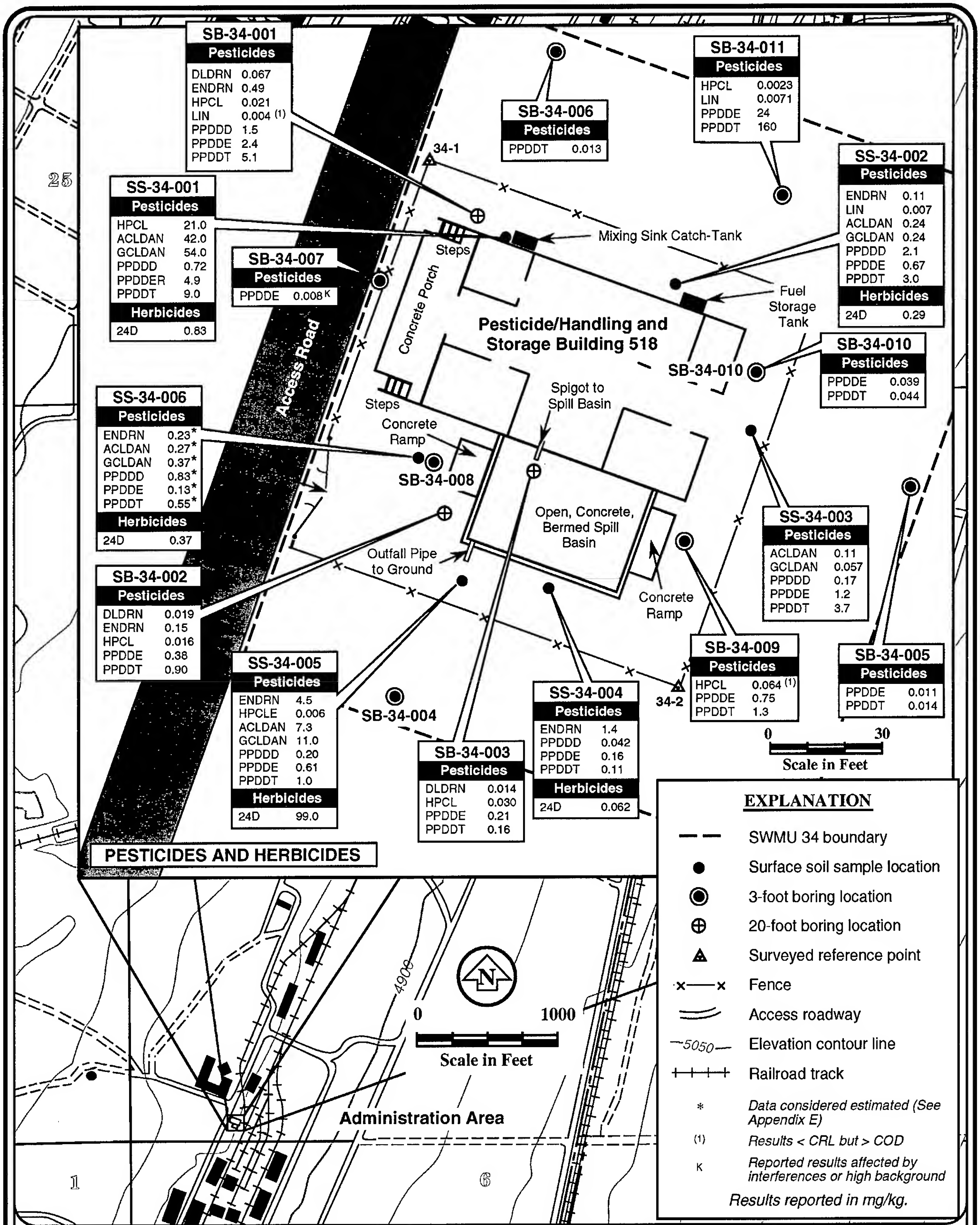
TEAD-N RFI—GROUP A SWMUs
SWMU 34
PESTICIDE HANDLING AND STORAGE AREA
ANALYTICAL RESULTS FOR SURFACE SOILS
FIGURE 11-2

PROJECT NO. 2942.0190



Source: Modified from USGS Tooele 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMU s

SWMU 34

PESTICIDE HANDLING AND STORAGE AREA
ANALYTICAL RESULTS FOR SURFACE SOILS

FIGURE 11-3

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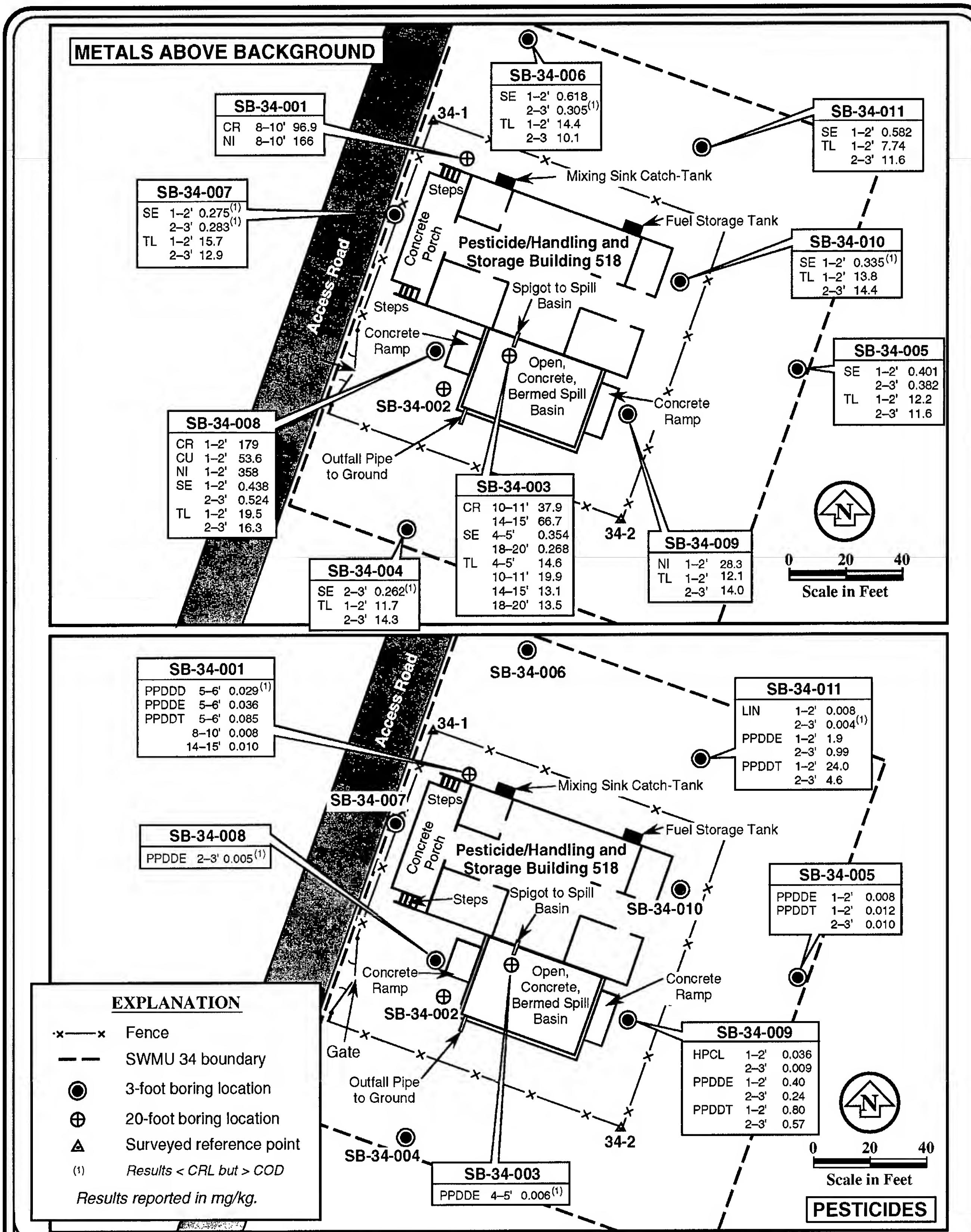
Analyte	Residential Threshold (mg/kg)	No. of Detections Exceeding Residential Threshold	Industrial Threshold mg/kg	No. of Detections Exceeding Industrial Threshold
Chlordane (alpha and gamma)*	0.1	3	0.45	3
Heptachlor	0.14	1	0.64	1
p,p-DDT	1.9	3	8.4	2
p,p-DDE	1.9	1	8.4	0

* Only Phase I results are listed for chlordane.

11.3.1.4. No petroleum hydrocarbons were detected in either the surface or subsurface intervals in soil boring SB-34-012, which was drilled and sampled adjacent to the above-ground heating oil tank. This boring was sampled only for TPH.

11.3.1.5. Shallow Subsurface Soils. Several metals above background were detected in the subsurface soils in nine of the eleven borings sampled for metals, as shown in Figure 11-4. Selenium and thallium were the metals detected most frequently, with chromium, copper, and nickel also detected above background. Thallium was detected in eight of the borings and selenium was detected in seven. These two metals were detected in uniform concentrations, with selenium values all between 0.2 mg/kg and 0.7 mg/kg, and thallium values all between 10 mg/kg and 20 mg/kg. The concentrations of all detected metals were low compared to the available risk-based soil guidance thresholds, with the exception of thallium. The thallium concentrations found do exceed the available risk-based guidance threshold for residential soils (assuming the conservative thallium chloride threshold of 6.3 mg/kg) but not the threshold for industrial/commercial soils of 82 mg/kg.

11.3.1.6. Pesticides were found in subsurface soils in six of the eleven borings sampled for these compounds. The deepest detection occurred in SB-34-001, drilled adjacent to the mixing sink catch tank on the north side of Building 518, where DDT was detected at a depth of 14 to 15 feet bgs. With one exception, all pesticide concentrations were less than the risk-based soil guidance thresholds (USEPA, 1994a). The guidance threshold for DDT in residential soils was exceeded in boring SB-34-011 in both sampled subsurface intervals (1 to 2 feet bgs and 2 to 3 feet bgs). This boring also showed a high concentration of DDT in the surface interval and may be a potential hot spot. Figure 11-4 shows the concentrations of pesticides detected in the subsurface soils.



Source: Modified from USGS Tooele 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 34
PESTICIDE HANDLING AND STORAGE AREA
ANALYTICAL RESULTS FOR SUBSURFACE SOILS
FIGURE 11-4

PROJECT NO. 2942.0190 10/23/95

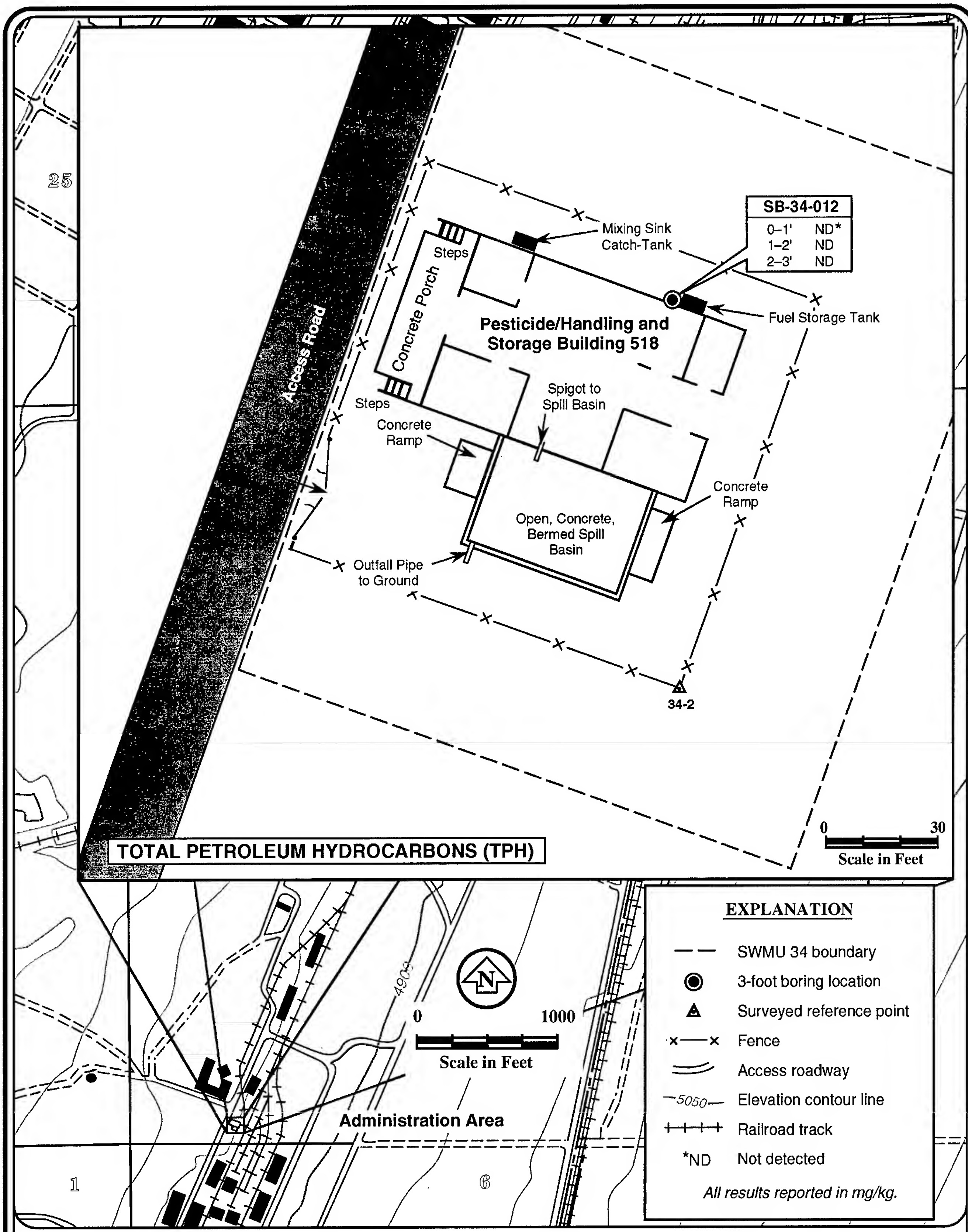
11.3.1.7. No TPH was detected in the subsurface soils collected from soil boring SB-34-012, as shown on Figure 11-5. Subsurface soil samples were collected from 1 to 2 feet bgs, and from 2 to 3 feet bgs.

11.3.2. Nature and Extent of Contamination

11.3.2.1. The results of the RFI soil sampling programs at SWMU 34 show elevated metals and pesticide compounds have been released to the nearby surface soils. Multiple thallium detections exceed the available risk-based soil guidance thresholds for a residential scenario used for comparison purposes in this report, but not for commercial or industrial uses. Two arsenic values from the surface soils also exceed the threshold for residential soils. Elevated lead levels are present in six of the sampled surface soils. Of the metals, only thallium is present in surface soil at elevated levels out to 50 feet away from Building 518 (i.e., outside the fenced compound). The uniform concentrations of the thallium detections, both in the surface and the subsurface soils, may result from elevated background levels of this element in the native fill used at and around the SWMU 34 area.

11.3.2.2. The distribution of pesticides is similar to that of metals at SWMU 34. Multiple pesticides are present in the surface soils around SWMU 34, and show decreasing concentrations with distance. One exception to this was seen in a 3-foot boring about 40 feet north of Building 518, where high concentrations of DDE and DDT were detected in both surface and subsurface soils. The vertical and horizontal extent of pesticide contamination has not been completely defined in this direction (northeast of Building 518). Trace amounts of DDD, DDE, and DDT persist to total depth in four of the 3-foot borings, and down to 15 feet bgs in the 20-foot boring located next to the mixing sink catch tank.

11.3.2.3. Groundwater underlying SWMU 34 was not sampled, but it is unlikely that SWMU 34 activities would have impacted groundwater here due to the depth to groundwater and lack of a driving force. Discharges to the stormwater system from SWMU 34, however, are a focus of activities at the Stormwater Discharge Area (SWMU 45), and are discussed in the context of that SWMU (Section 14.0).



Source: Modified from USGS Tooele 7.5 minute quadrangle.

TEAD-N RFI—GROUP A SWMUs
SWMU 34
PESTICIDE HANDLING AND STORAGE AREA
TPH RESULTS FOR SURFACE AND SUBSURFACE SOILS
FIGURE 11-5

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11.3.3. Selection of COPCs and COPECs

11.3.3.1. Identification of COPCs. The selection of the COPCs for the Pesticide Storage Area (SWMU 34) was based on the screening procedures outlined in Section 3.2.6. A summary of all chemicals detected in samples from SWMU 34, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationale for the analytes not selected as COPCs are shown in Table 11-1. Chromium has been assumed to be present in the trivalent state because there is no historical information that compounds containing hexavalent chromium were ever used at SWMU 34. No literature exists indicating that hexavalent chromium is, or ever was, used in pesticides or herbicides.

11.3.3.2. Chemicals of potential concern selected for the human health risk assessment at SWMU 34 include the metals arsenic, cadmium, chromium, lead, mercury, nickel, and thallium. Organic chemicals of potential concern include the herbicide 2,4-D and the pesticides DDE, DDT, and endrin. Also addressed qualitatively is chlordane, which was tentatively identified in Phase I sampling but not detected in Phase II. Because chlordane was detected in Phase I only as a tentatively identified compound (TIC), the data have a lower degree of confidence.

11.3.3.3. Identification of COPECs. The COPECs were selected based on the criteria outlined in the methodology discussion (Section 3.2.7.). The COPECs that are evaluated in Tier 2 and the reason for the exclusion of analytes from further evaluation are presented in Table 11-1. The inorganic COPECs consist of arsenic, cadmium, lead, nickel, thallium, and zinc. The organic COPECs at SWMU 34 are 2,4-D, DDE, and DDT.

11.3.4. Contaminant Fate and Transport

11.3.4.1. As discussed in section 11.3.3. the contaminants of concern at SWMU 34 include metals, pesticides, and herbicides (Table 11-1). Table 3-4 briefly describes the fate and transport characteristics for each of the contaminants of concern identified in Table 11-1. The remainder of this section presents a conceptual model of contaminant fate and transport at SWMU 34 and discusses the expected fate and transport of the contaminants of concern.

TABLE 11-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN
FOR ANALYTES DETECTED IN SOIL AT SWMU 34–PESTICIDE STORAGE AREA

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluate in Risk Assessment	
			Human	Ecological
Aluminum	7.47E+03	100	No(a)	No(a)
Arsenic	**4.20E+01**	**100**	**Yes**	**Yes**
Barium	1.04E+02	100	No(a)	No(a)
Beryllium	9.51E-01	42	No(a)	No(a)
Cadmium	**1.16E+01**	**24**	**Yes**	**Yes**
Chromium	**9.69E+01**	**100**	**Yes**	No(d)
Cobalt	5.17E+00	97	No(a)	No(a)
Copper	1.80E+02	100	No(b)	No(d)
Cyanide	2.88E+00	17	No(c)	No(d)
Lead	**1.12E+03**	**74**	**Yes**	**Yes**
Manganese	3.23E+02	100	No(a)	No(a)
Mercury	**5.00E-02**	**5**	**Yes**	No(d)
Nickel	**1.84E+02**	**100**	**Yes**	**Yes**
Selenium	6.18E-01	50	No(c)	No(d)
Thallium	**1.99E+01**	**82**	**Yes**	**Yes**
Vanadium	1.32E+01	100	No(a)	No(a)
Zinc	2.21E+03	100	No(b)	**Yes**
2,4-D	**9.90E+01**	**83**	**Yes**	**Yes**
Dieldrin	6.70E-02	8	No(c)	No(d)
Endrin	**4.50E+00**	**16**	**Yes**	No(d)
Heptachlor	2.10E-02	3	No(c)	No(d)
Lindane	7.10E-02	13	No(c)	No(d)
p,p-DDD	1.53E+00	21	No(c)	No(d)
p,p-DDE	**2.40E+01**	**58**	**Yes**	**Yes**
p,p-DDT	**1.60E+02**	**58**	**Yes**	**Yes**

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium
Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

(a) Analyte was detected at or below background concentrations
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte contributed less than 1 percent in a concentration - toxicity screen
(d) Maxiumum concentration less than NOAEL or estimate of NOAEL

11.3.4.2. Conceptual Model. A conceptual site model of contaminant transport (Figure 11-6) has been developed based on the physical site characteristics presented in Section 2.0 and the contamination assessment presented above. This model displays the potential routes of contaminant migration from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear unlikely based on available data. Contamination has been released to the surface and subsurface soils at SWMU 34 from mixing/formulation of pesticides, spills of pesticides from filling tanks, rinsing containers with pesticides, pesticide and herbicide storage, and possible leakage from drains connected to the stormwater drain system. The surface and shallow soils at SWMU 34 consist of silty and sandy gravels (USSCS, 1991). Groundwater is approximately 375 feet bgs at this site and surface runoff is mainly controlled by the stormwater drainage system. Currently, there are no unblocked storm drain openings within the fenced area of SWMU 34.

11.3.4.3. Fate and Transport of Metals. Based upon the current known conditions, it appears unlikely that metals will migrate to groundwater based on the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow soils, neutral to slightly basic pH soils, and a depth to groundwater of approximately 375 feet. Off-site migration of metal contaminants via a surface water pathway is not expected to be significant because the area is covered by asphalt or concrete, and surface runoff drains to the storm water system or remains contained in the bermed spill basin. The metals in the surface soils may provide particulates to the air pathway at this site.

11.3.4.4. Fate and Transport of Pesticides and Herbicides. Table 3-4 briefly describes the fate and transport characteristics of pesticides and herbicides. Generally, chlorinated pesticides will strongly adsorb to soils and resist leaching to deeper soil horizons and groundwater as indicated by their high K_{OC} partitioning coefficients (see Table 3-3). However, DDT has been detected as deep as 15 feet bgs in the vicinity of the mixing sink catch-tank (see Figure 11-4). Pesticides tend to volatilize slowly from surface soil, which could be a significant fate process (but not a major exposure pathway). Pesticides may also adsorb to particulates and be transported via the air pathway where they may be slowly photo-oxidized and removed by wet/dry deposition. Pesticides are resistant to biode-gradation and are persistent in the environment.

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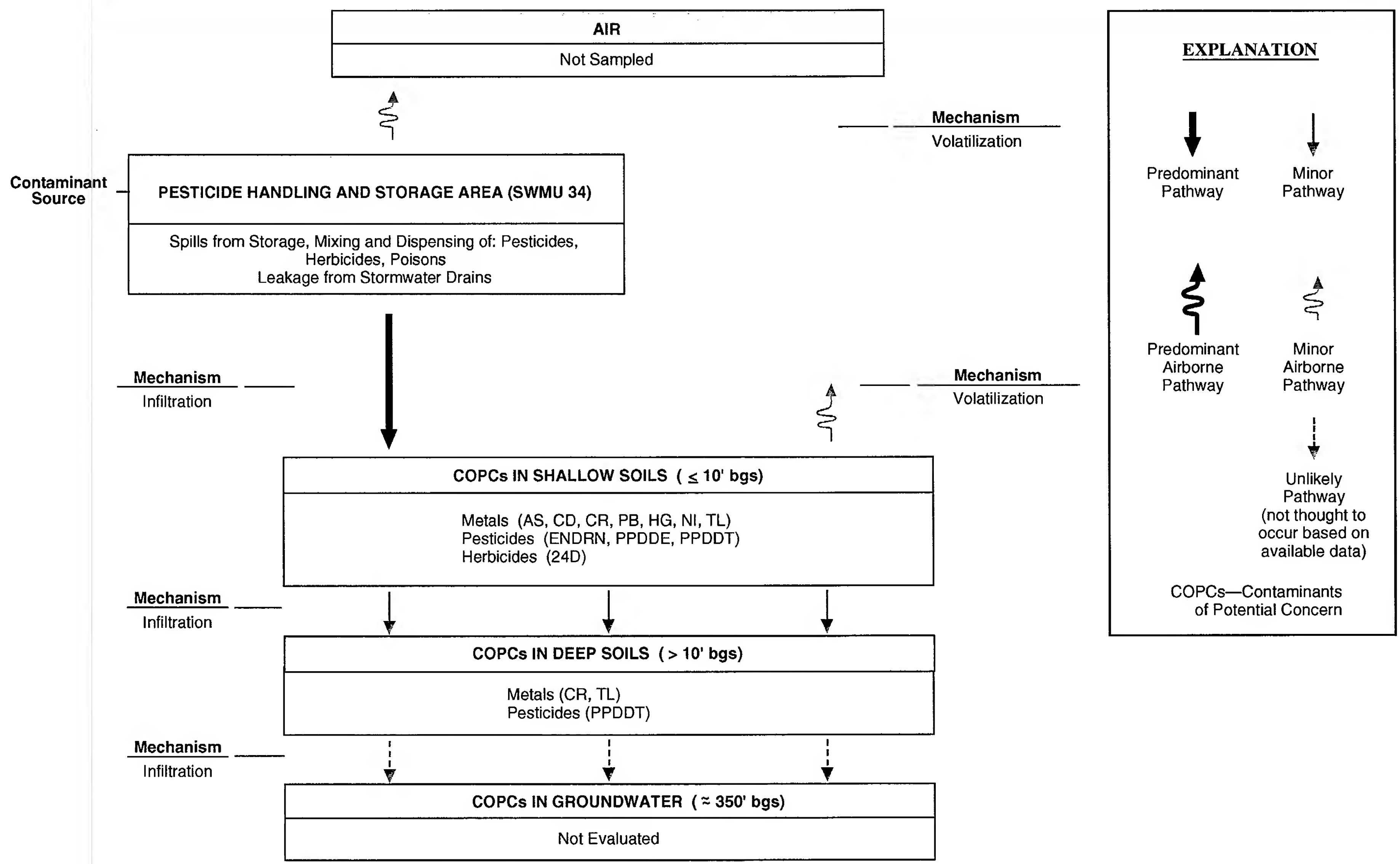

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TEAD-N RFI—GROUP A SWMUs

PESTICIDE HANDLING AND STORAGE AREA—SWMU 34
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT

FIGURE 11-6

11.3.4.5. The herbicide 2,4-D, behaves much differently in the environment than the pesticides. 2,4-D adsorbs weakly to soils and tends to be mobile, especially in coarse grained soils and basic pH conditions. Transport of 2,4-D from the surface soils to groundwater is not expected because concentrations are relatively low in the shallow soils, the precipitation rate is low compared to the high evaporation rate and groundwater is about 375 feet bgs. However, migration to soil horizons deeper than 10 feet bgs can be anticipated. Volatilization from surface soils and water is not expected to be significant, but 2,4-D will readily biodegrade in surface and subsurface soils. 2,4-D may weakly adsorb to particulates and be transported by the air pathway where it may be subject to photo-oxidation and be removed by wet/dry deposition.

11.4 HUMAN HEALTH RISK ASSESSMENT

11.4.0.1. The methods used to estimate the risks associated with SWMU 34 are given in the Human Health Risk Assessment Methodology, Section 3.2.6. The COPCs were identified in the previous section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 34) is presented in the following sections.

11.4.1. Exposure Pathways and Receptors

11.4.1.1. The pathways quantitatively evaluated in the BRA are: (1) those that are complete or likely to be completed in the future, and (2) those that may potentially cause a significant risk. An evaluation of completeness is shown as an exposure pathway diagram for SWMU 34 (Figure 11-7). An evaluation of pathway completeness and an assessment of whether a pathway is significant enough to require further evaluation for current and potential future receptors at SWMU 34 are given in Tables 11-2 and 11-3, respectively.

11.4.1.2. No current receptors were evaluated for SWMU 34. The Pesticide Storage Building is currently being decommissioned and no future pesticide-related activities are planned. On-Depot pesticide and herbicide applications will be conducted by a contractor. The building and surrounding yard are enclosed with a cyclone fence and posted with warning signs. No signs of trespassing have been observed.

11.4.1.3. Potential future on-Depot receptors for contaminants originating from SWMU 34 include Depot workers, construction workers, and TEAD-N residents. As shown on the exposure pathway diagram (Figure 11-7), Depot personnel were assumed to

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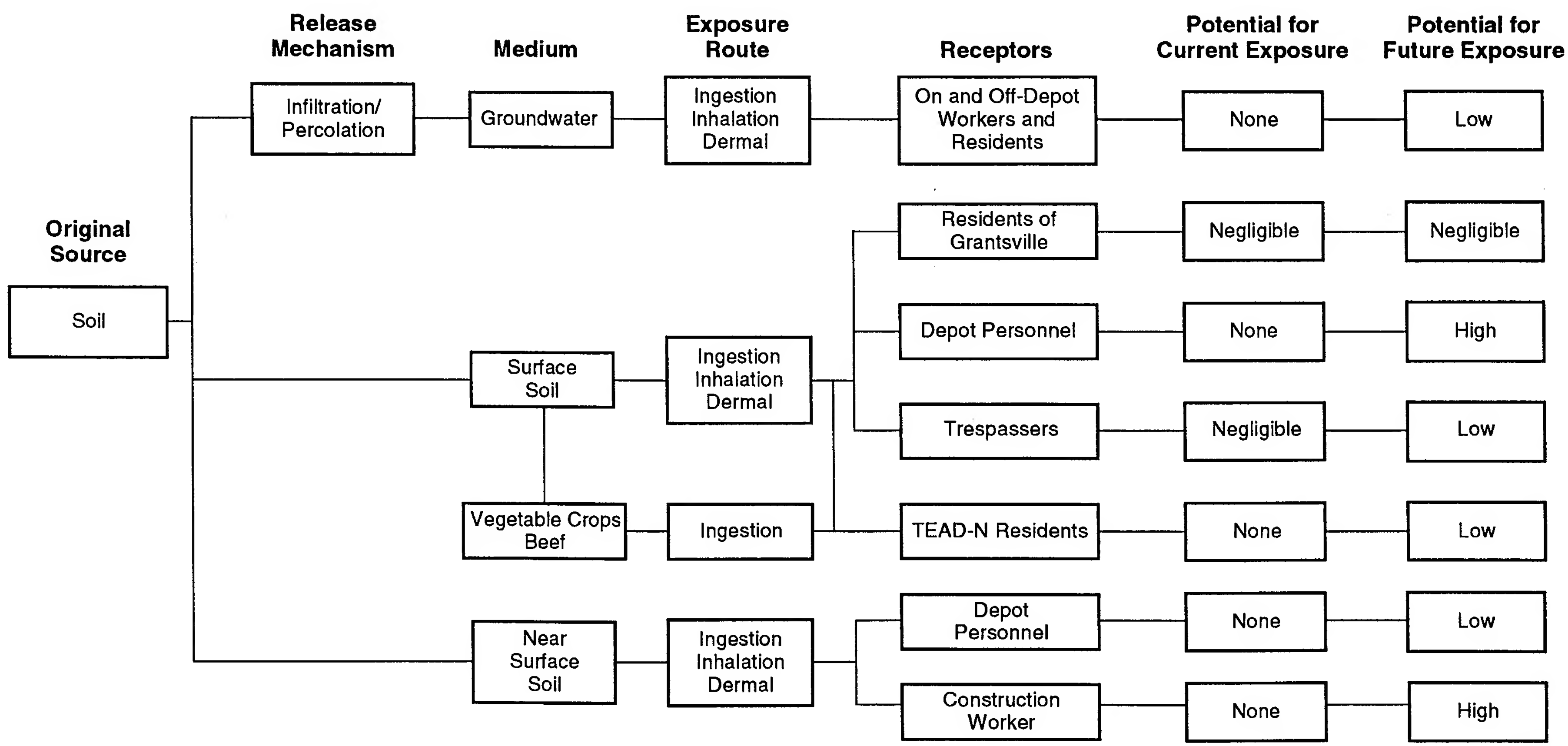

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TEAD-N RFI—GROUP A SWMUs
SWMU 34—PESTICIDE STORAGE AREA EXPOSURE PATHWAYS DIAGRAM
FIGURE 11-7

TABLE 11-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 34: PESTICIDE STORAGE AREA

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is approximately 375 feet below the ground surface, evapotranspiration is high, and primary contaminants (i.e. pesticides such as DDT) have low mobility.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 34 is small and the amount of dust in Grantsville originating from SWMU 34 will be minuscule.
	Depot Personnel	Incidental ingestion of dust, inhalation, and dermal contact	No. Depot personnel no longer perform pesticide operations and building is unused.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. No evidence of trespassing observed. Facility is labeled with warning signs and secured with a chain-linked fence.
Air	Depot Personnel	Inhalation of volatile organics from subsurface soil	No. Contaminants are not volatile. Dust exposure evaluated under soil.

TABLE 11-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 34: PESTICIDE STORAGE AREA

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is approximately 375 feet below the ground surface, evapotranspiration is high, and primary contaminants (i.e. pesticides such as DDT) have low mobility.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 34 is small and the amount of dust in Grantsville originating from SWMU 34 will be minuscule.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. While this SWMU is not within the existing closure parcel, residential development would be possible if this area of the Depot was closed in the future. Surface soil is contaminated.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Depot personnel	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Because pesticide operations have been terminated, the future use of this facility is uncertain.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers are not expected and the exposure will be less than for a future resident.
Near-Surface Soil	Construction workers	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Near-surface soil is contaminated and future land use is uncertain.
Air	Future TEAD-N residents	Inhalation of volatile organics from subsurface soil	No. Volatile organics have not been detected. Dust exposure evaluated under soil.

TEAD-N Tooele Army Depot North Area

be indirectly exposed to soil by ingestion, dermal contact, and inhalation of dust. Construction workers also may be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For construction workers, direct exposure would result from the anticipated excavation activities associated with construction or demolition of a building, and includes both surface and subsurface soil. Should this portion of the Depot be closed in the future (it is not slated for closure at this time), future residents could become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. While there are no plans at this time to convert SWMU 34 into part of a residential development, a residential scenario was evaluated as per the requirements of UAC 315-101 (1994).

11.4.1.4. SWMU 34 could be converted into an area where crops are grown and future residents could eat the fruits and vegetables that are grown. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. These pathways are evaluated as part of the future residential scenario.

11.4.1.5. For the pathways that were quantitatively evaluated (see Tables 11-2 and 11-3), site-specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are presented in Appendix K.

11.4.2. Risk Characterization

11.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 34. The methods for calculating the risks are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

11.4.2.2. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable (unless there are reasons to believe the risks have been underestimated), a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects are possible. Adult blood lead levels between 10 and 15 micrograms per deciliter

(μg/dl) is a benchmark range based on hypertension in adult males and transfer of lead from a pregnant mother to her fetus. For children, 10 μg/dl is the benchmark typically used by the EPA (USEPA, 1994; see Section 3.2.6. for a discussion of the calculation of blood lead concentrations for adults and children).

11.4.2.3. In addition to the calculated estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for potential Depot personnel, construction workers, and TEAD-N residents.

11.4.2.4. Depot Personnel. As shown on Table 11-4, the estimated excess lifetime cancer risk for future Depot personnel working at SWMU 34 is 1×10^{-5}, which is in the range where the non-quantitative factors are critical in determining the significance of the risks. Most of the calculated cancer risk is from dermal exposure to DDT and ingestion of arsenic. Arsenic is classified by EPA as a Class A (known human) carcinogen, while DDT is classified as a B2 (probable human) carcinogen. The pathway has a high potential to be completed in the future. Using a typical, but conservative, chlordane concentration of 3 mg/kg (this value is higher than all but two results), the total cancer risk estimate for the Depot worker would be 7×10^{-6}.

11.4.2.5. It is likely that a realistic estimate of the cancer risk would be less than 1×10^{-6} due to overestimates of the exposure duration, exposure point concentrations, ingestion rate, and dust level, as explained in the discussion of uncertainties (Section 11.4.3.). This is demonstrated by a risk estimate of 8×10^{-7} based on CTE parameters (see Table 11-5). The most likely source of a cancer risk greater than 1×10^{-6} is if dermal absorption is greater than was estimated for pesticides. If the pesticides are absorbed through the skin in a much greater proportion than the assumed 3 percent, then a dermal risk estimate between 1×10^{-5} and 1×10^{-6} may be realistic. A summary of the risk estimates and qualitative factors affecting these estimates is presented in Table 11-6.

11.4.2.6. The total hazard index for future Depot personnel was estimated to equal 0.2, indicating that health effects other than cancer are not expected. This value would be unaffected by the inclusion of chlordane at 3 mg/kg. While the inhalation exposure

TABLE 11-4

SWMU 34 - PESTICIDE STORAGE AND HANDLING AREA
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR DEPOT PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.6E+01	5E-06	2E-07	4E-07	6E-06	47
Cadmium	2.7E+00	NC	NC	3E-08	3E-08	<1
DDE	4.5E+00	3E-07	4E-07	3E-09	7E-07	5
DDT	2.7E+01	2E-06	4E-06	2E-08	6E-06	47
Pathway Total		7E-06	5E-06	5E-07		
Percent of Total		57	39	4		
			Total Cancer Risk:		**1E-05**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	1.6E+01	3E-02	1E-03	NC	3E-02	13
Cadmium	2.7E+00	1E-03	8E-04	NC	2E-03	1
Chromium(III)	1.7E+01	8E-06	9E-06	NC	2E-05	<1
Lead	2.4E+02	NC	NC	NC	NC	NC
Mercury	2.8E-02	5E-05	1E-05	2E-06	6E-05	<1
Nickel	1.5E+01	4E-04	2E-04	NC	5E-04	<1
Thallium	1.2E+01	7E-02	3E-03	NC	8E-02	35
24D	5.0E+01	2E-03	6E-03	NC	9E-03	4
DDE	4.5E+00	NC	NC	NC	NC	NC
DDT	2.7E+01	3E-02	7E-02	NC	1E-01	44
Endrin	8.6E-01	1E-03	4E-03	NC	5E-03	2
Pathway Total		1E-01	8E-02	2E-06		
Percent of Total		61	39	<1		
			Total Hazard Index:		**2E-01**	
		Blood Lead Concentration µg/dl (95th percentile):			**3.7**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 11-5

SWMU 34 - PESTICIDE STORAGE AND HANDLING AREA
CTE CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR DEPOT PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.6E+01	4E-07	7E-09	3E-10	5E-07	60
Cadmium	2.7E+00	NC	NC	2E-11	2E-11	<1
DDE	4.5E+00	2E-08	1E-08	2E-12	4E-08	5
DDT	2.7E+01	1E-07	1E-07	1E-11	3E-07	36
Pathway Total		6E-07	1E-07	3E-10		
Percent of Total		80	20	<1		
			Total Cancer Risk:		**8E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	1.6E+01	1E-02	2E-04	NC	1E-02	17
Cadmium	2.7E+00	6E-04	1E-04	NC	7E-04	1
Chromium(III)	1.7E+01	4E-06	1E-06	NC	5E-06	<1
Lead	2.4E+02	NC	NC	NC	NC	NC
Mercury	2.8E-02	2E-05	2E-06	6E-09	2E-05	<1
Nickel	1.5E+01	2E-04	2E-05	NC	2E-04	<1
Thallium	1.2E+01	3E-02	5E-04	NC	3E-02	46
24D	5.0E+01	1E-03	1E-03	NC	2E-03	3
DDE	4.5E+00	NC	NC	NC	NC	NC
DDT	2.7E+01	1E-02	1E-02	NC	2E-02	32
Endrin	8.6E-01	6E-04	6E-04	NC	1E-03	2
Pathway Total		6E-02	1E-02	6E-09		
Percent of Total		81	19	<1		
			Total Hazard Index:		**7E-02**	
		Blood Lead Concentration µg/dl (50th percentile):			**2.1**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
CTE Central tendency exposure

TABLE 11-6

TEAD-N BASELINE RISK ASSESSMENT
SWMU 34–PESTICIDE STORAGE AREA PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (µg/dl)	Key Chemicals[a]
Depot Personnel					3.7	
Ingestion	Future likely	Medium/High	0.1	7×10^{-6}		Arsenic, thallium, DDT
Dermal	Future likely	High/Neutral-High	0.08	5×10^{-6}		
Inhalation	Future likely	High/High	0.000002	5×10^{-7}		
Construction Worker					3.6	
Ingestion	Future likely	Medium/High	0.2	8×10^{-7}		Arsenic, thallium, DDT
Dermal	Future likely	High/Neutral-High	0.04	9×10^{-8}		
Inhalation	Future likely	Medium/High	0.00003	2×10^{-7}		
TEAD-N Resident					7.5	
Ingestion	Future unlikely	Medium/High	3	6×10^{-5}		Arsenic, thallium, DDT
Dermal	Future unlikely	High/Neutral-High	0.3	1×10^{-5}		
Inhalation	Future unlikely	High/High	0.00001	1×10^{-6}		
Vegetable Crops	Future unlikely	High/Neutral	9	3×10^{-4}		
Beef	Future unlikely	High/Neutral	0.0001	2×10^{-9}		

NC Not calculated
TEAD-N Tooele Army Depot North Area

(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

pathway has not been accounted for due to the absence of inhalation reference doses for the COPCs, the exposure doses are in a range where adverse health effects are unlikely (see Section 11.4.3. regarding this issue; exposure doses are presented in Appendix K). The concentration of lead in blood was estimated to be 3.7 µg/dl, which indicates that workers would not be at risk for adverse effects from lead.

11.4.2.7. Potential Future Construction Worker. The excess lifetime cancer risk for potential future construction workers was estimated to equal 1 x 10^{-6} (Table 11-7). This risk estimate would be unchanged by the inclusion of chlordane. Most of the calculated risk is generated by the inhalation and ingestion of arsenic and, to a lesser extent, the ingestion of DDT. Like the Depot worker, the significance of the cancer risk estimate is increased because the pathways have a reasonable potential to be completed in the future, and because a Class A carcinogen (arsenic) is responsible for most of the cancer risk. However, as in the case of the future Depot worker, it is expected that the cancer risk estimates are biased high, and the actual cancer risk is less than 1 x 10^{-6}. Reasons include the biased (judgmental) sampling used during the field investigation and factors such as the concentration of contaminated dust and the soil ingestion rate that tend to overestimate ingestion and inhalation risks. A cancer risk of 3 x 10^{-7} was estimated using CTE parameters (see Table 11-8). These conclusions are not altered by including chlordane in the risk calculations at its maximum detected concentration.

11.4.2.8. The total hazard index was estimated to equal 0.2 and the concentration of lead in blood was estimated to be 3.6 µg/dl. Inclusion of chlordane at 3 mg/kg would increase the hazard index to 0.4. While the hazard index does not include the inhalation pathway for most of the COPCs due to the absence of inhalation reference doses, the inhalation pathway is not expected to be significant for the reasons described for the Depot worker. No adverse effects are expected from the calculated blood lead concentration.

11.4.2.9. Potential Future TEAD-N Resident. For SWMU 34, the cancer risk from all exposure pathways was estimated to equal 4 x 10^{-4}, and the hazard index was estimated to equal 10. As shown in Table 11-9, the excess lifetime cancer risk for potential future residents exposed to soil at SWMU 34 was estimated to equal 8 x 10^{-5}. If chlordane was included at a concentration of 3 mg/kg, the cancer risk estimate would be 9 x 10^{-5}. Most of the calculated cancer risk is from ingestion of arsenic and ingestion and dermal exposure to DDT and DDE. The significance of these risk estimates is diminished because it is unlikely that a home will be built where the Pesticide Storage Building is located. If a home is built, most of the contaminated soil will probably be covered by pavement or grass. However, half of the cancer risk is attributable to a Class A carcinogen (arsenic), which increases the

TABLE 11-7

SWMU 34 - PESTICIDE STORAGE AND HANDLING AREA
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	9.7E+00	6E-07	5E-09	2E-07	8E-07	74
Cadmium	1.4E+00	NC	NC	1E-08	1E-08	1
DDE	2.1E+00	2E-08	7E-09	1E-09	3E-08	3
DDT	1.3E+01	1E-07	8E-08	6E-09	2E-07	22
Pathway Total		8E-07	9E-08	2E-07		
Percent of Total		71	9	21		
			Total Cancer Risk:		**1E-06**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	9.7E+00	8E-02	7E-04	NC	8E-02	32
Cadmium	1.4E+00	3E-03	4E-04	NC	4E-03	2
Chromium(III)	2.3E+01	5E-05	1E-05	NC	7E-05	<1
Lead	1.1E+02	NC	NC	NC	NC	NC
Mercury	2.6E-02	2E-04	1E-05	3E-05	2E-04	<1
Nickel	2.9E+01	3E-03	3E-04	NC	4E-03	2
Thallium	1.2E+01	4E-02	3E-04	NC	4E-02	16
24D	5.2E+01	1E-02	7E-03	NC	2E-02	8
DDE	2.1E+00	NC	NC	NC	NC	NC
DDT	1.3E+01	6E-02	3E-02	NC	9E-02	39
Endrin	3.8E-01	3E-03	2E-03	NC	5E-03	2
Pathway Total		2E-01	4E-02	3E-05		
Percent of Total		82	18	<1		
			Total Hazard Index:		**2E-01**	
	Blood Lead Concentration µg/dl (95th percentile):				**3.6**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 11-8

SWMU 34 - PESTICIDE STORAGE AND HANDLING AREA
CTE CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	9.7E+00	2E-07	9E-10	8E-08	2E-07	78
Cadmium	1.4E+00	NC	NC	5E-09	5E-09	2
DDE	2.1E+00	7E-09	1E-09	4E-10	8E-09	3
DDT	1.3E+01	4E-08	1E-08	2E-09	6E-08	18
Pathway Total		2E-07	2E-08	9E-08		
Percent of Total		67	5	28		
			Total Cancer Risk:		3E-07	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	9.7E+00	2E-02	1E-04	NC	2E-02	14
Cadmium	1.4E+00	9E-04	7E-05	NC	1E-03	<1
Chromium(III)	2.3E+01	2E-05	2E-06	NC	2E-05	<1
Lead	1.1E+02	NC	NC	NC	NC	NC
Mercury	2.6E-02	6E-05	2E-06	1E-05	7E-05	<1
Nickel	2.9E+01	1E-03	5E-05	NC	1E-03	<1
Thallium	1.2E+01	1E-01	6E-04	NC	1E-01	67
24D	5.2E+01	3E-03	1E-03	NC	5E-03	3
DDE	2.1E+00	NC	NC	NC	NC	NC
DDT	1.3E+01	2E-02	6E-03	NC	2E-02	15
Endrin	3.8E-01	8E-04	3E-04	NC	1E-03	<1
Pathway Total		1E-01	8E-03	1E-05		
Percent of Total		95	5	<1		
			Total Hazard Index:		2E-01	
	Blood Lead Concentration g/dl (50th percentile):				2.0	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
CTE Central tendency exposure

TABLE 11-9

SWMU 34 - PESTICIDE STORAGE AND HANDLING AREA
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.6E+01	5E-05	6E-07	1E-06	9E-05	8E-11	1E-04	36
Cadmium	2.7E+00	NC	NC	8E-08	NC	NC	8E-08	<1
DDE	4.5E+00	2E-06	1E-06	8E-09	1E-05	8E-10	2E-05	4
DDT	2.7E+01	1E-05	1E-05	5E-08	2E-04	8E-10	2E-04	60
Pathway Total		6E-05	1E-05	1E-06	3E-04	2E-09		
Percent of Total		16	3	<1	81	<1		
					Total Cancer Risk:		4E-04	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	1.6E+01	7E-01	5E-03	NC	9E-01	1E-06	2E+00	13
Cadmium	2.7E+00	3E-02	3E-03	NC	7E-01	1E-08	7E-01	6
Chromium (III)	1.7E+01	2E-04	4E-05	NC	8E-05	4E-10	3E-04	<1
Lead	2.4E+02	NC	NC	NC	NC	NC	NC	NC
Mercury	2.8E-02	1E-03	5E-05	1E-05	4E-03	5E-10	5E-03	<1
Nickel	1.5E+01	9E-03	6E-04	NC	1E-02	2E-08	2E-02	<1
Thallium	1.2E+01	2E+00	1E-02	NC	2E-01	7E-05	2E+00	17
24D	5.0E+01	6E-02	3E-02	NC	NC	NC	9E-02	<1
DDE	4.5E+00	NC	NC	NC	NC	NC	NC	NC
DDT	2.7E+01	7E-01	3E-01	NC	7E+00	3E-05	8E+00	62
Endrin	8.6E-01	4E-02	1E-02	NC	NC	NC	5E-02	<1
Pathway Total		3E+00	3E-01	1E-05	9E+00	1E-04		
Percent of Total		28	3	<1	69	<1		
					Total Hazard Index:		1E+01	
			Blood Lead Concentration µg/dl (95th percentile):				7.5	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure
TEAD-N Tooele Army Depot North Area

significance of the risks. Because of the likely overestimates of the exposure point concentration and the ingestion rate for arsenic, it is likely that a more realistic estimate of the potential cancer risk is between 1 x 10^{-6} and 1 x 10^{-5}.

11.4.2.10. The total hazard index for potential future child residents exposed to soil was estimated to equal 4. The majority of the hazard index is derived from the ingestion of thallium and arsenic, and ingestion and dermal exposure to DDT. The blood lead concentration was estimated to equal 7.5 μg/dl, which is below the benchmark concentration of 10 μg/dl. Half of the hazard index is attributable to the ingestion of thallium. However, thallium may be present at background concentrations rather than as a contaminant. Thallium was detected with a maximum concentration in surface soil of 12 mg/kg. While the background threshold for thallium is 6.6 mg/kg for this area of the Depot, other areas of the Depot had a background threshold greater than 12 mg/kg (i.e., some soils at TEAD-N have background thallium concentrations comparable to what was detected at SWMU 34).

11.4.2.11. The significance of the hazard index from exposure to soil is also reduced because the exposure doses are probably overestimated. Likely overestimates include exposure point concentrations, the exposure frequency, and the soil ingestion rate. The absence of inhalation reference doses is unlikely to be a major omission due to the low probability of generating significant levels of dust in a residential setting. Consequently, the hazard index is probably less than 1. In summary, the exposure to soil in a residential setting is high enough to generate a cancer risk that could be significant, but residents are not expected to live at SWMU 34 in the foreseeable future.

11.4.2.12. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 34, the estimated cancer risk is 3 x 10^{-4} and the hazard index is 9 (Table 11-9), primarily due to arsenic and DDT. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has a high degree of uncertainty because of uncertainties in the plant uptake factors (see Section 11.4.3.).

11.4.2.13. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 34, the estimated cancer risk is 2 x 10^{-9} and the hazard index is 0.0001 (Table 11-9). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 34 if

they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

11.4.3. Uncertainties

11.4.3.1. The exposure estimates and toxicity values have associated uncertainties, the magnitude and nature of which affect the confidence in the results. Most of the uncertainties are such that risk estimates could be lower, but are unlikely to be higher than estimated. The following paragraphs discuss uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor. These discussions are focused on elements contributing the most to overestimates of the total risk, and on those elements where risks may be underestimates. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk.

11.4.3.2. Sampling at SWMU 34 included judgmental samples from areas where stained soil was observed, and areas likely to have received spills and surface runoff. Consequently, the exposure point concentrations are biased high. One sample (SB-34-00C, 3.0 feet bgs) exceeded the holding time for pesticides by two days; however, this is not anticipated to affect the estimation of the exposure point concentration for three reasons. First, the measured concentration for all pesticides was below the level of detection in this sample. Second, the holding time was exceeded by only two days, which would limit the magnitude of the low bias, and third, the effect on the average of one out of 38 samples is small.

11.4.3.3. The exposure point concentration of chlordane has a high degree of uncertainty because this pesticide was not detected in Phase II and was only tentatively identified in Phase I. While typical chlordane concentrations had little influence on the total risk estimates, use of the maximum concentration of 96 mg/kg could result in a cancer risk in the vicinity of 1×10^{-4} for the future resident, and between 1×10^{-4} and 1×10^{-5} for the potential future Depot worker.

11.4.3.4. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

11.4.3.5. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical (tetraethyl lead) with a reference dose below 1×10^{-6} mg/kg/day , and this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation of metals with exposure doses greater than 1×10^{-6} was examined on a case-by-case basis. The results of this evaluation were presented in Section 11.4.2. Exposure doses are summarized in Appendix K.

11.4.3.6. Depot Worker. One factor affecting the cancer risk estimates for the Depot worker is the assumption that exposure will take place over a 25-year period. Most people change jobs, or their job location, more frequently. The resulting cancer risk would be reduced according to how long a person is actually at the contaminated job location.

11.4.3.7. The greatest uncertainty related to inhalation exposure is the assumed dust level of 50 $\mu g/m^3$, which is the National Ambient Air Quality Standard for respirable dust. Because SWMU 34 is small and mostly paved, only a small fraction of the dust will originate within the SWMU, and using a value of 50 $\mu g/m^3$ will overestimate the resulting inhalation exposure.

11.4.3.8. Uncertainties related to ingestion exposure derive primarily from the soil ingestion rate. A typical ingestion rate for adults is probably closer to 25 mg/day (DTSC, 1992), rather than the 50 mg/day assumed in this risk assessment. Also, while soil contaminants were assumed to be 100 percent bioavailable, the actual bioavailability may be substantially less. Dermal exposure uncertainties are associated with the amount of skin covered with soil and the fraction of contaminant absorbed through the skin. While estimates of the area of exposed skin are fairly realistic, it is likely that less than 100 percent of the exposed skin becomes covered with soil. Consequently, the area of exposure (i.e., the skin surface area) assumed here will be an overestimate. Also, recent EPA research indicates that the soil adherence factor applies only to the front part of the hands (i.e., the side with the palms), and the adherence factor for the rest of the body is five times lower. As has been seen, dermal exposure is the route leading to the greatest exposure for pesticides. Dermal absorption of DDT (which is the pesticide at this SWMU present in the highest concentration) has been studied, but deficiencies in the experiment design indicate that there is an uncertainty of about an order of magnitude, either higher or lower, in the absorption factor. Comparable or larger uncertainties accompany the other pesticides detected at this SWMU, which have not been studied.

11.4.3.9. Construction Worker. Uncertainties associated with the exposure dose for a construction worker are high. For excavation work at SWMU 34, the exposure point concentrations below the ground surface are a source of uncertainty because only three samples were collected from depths between 5 and 12 feet bgs. Using data from shallow soil only would tend to overestimate the concentrations because the COPCs at SWMU 34 are not known to have been directly released to the subsurface, and are relatively immobile (see Section 11.3.4., Contaminant Fate and Transport).

11.4.3.10. As in the case of the Depot worker, uncertainties associated with estimates of dermal exposure include amount of skin covered with soil and the fraction of contaminant absorbed through the skin. Ingestion uncertainties are greater for the construction worker than for the Depot worker. As discussed in relation to SWMU 1, ingestion rates are likely to be at least a factor of 3.5 less than what was assumed in this BRA. If the bioavailability of COPCs is less than 100 percent, then ingestion exposure will be further reduced compared to the estimated dose.

11.4.3.11. Similar to the Depot worker, uncertainties related to inhalation exposure are primarily associated with the dust concentration. The amount of wind-generated dust from SWMU 34 is expected to be low based on the small size of this SWMU and the

fact that it is mostly paved. Unless a construction project generates dust levels on the order of 1 mg/m^3, typical dust levels would probably be one or more orders of magnitude less than the 1 mg/m^3 assumed in this BRA.

11.4.3.12. TEAD-N Residents. The uncertainties for construction and Depot workers are also uncertainties in the evaluation of future residents at TEAD-N, although the magnitude of the uncertainties differs. In a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure, and (to a lesser extent) reduces the potential for dermal and ingestion exposure. As in the case of the workers, uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the dust level. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who directly eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate exceeds the assumed rate of 200 mg/day. For dermal exposure, young children may cover their exposed skin with soil more completely than adults. The assumed skin surface area is probably more reasonable for this age group than for adults.

11.4.3.13. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

11.4.3.14. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53. While uptake factors for metals are based on empirical data, they have uncertainties of the same magnitude due to the factors described in the previous paragraph. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

11.4.4. Recommendations

11.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Allow unrestricted short-term use (up to two years) of SWMU 34 by depot workers.
- Further evaluate the potential presence of a hot spot of chlordane.
- Evaluate the need for institutional controls and/or corrective action in a Corrective Measures Study.

11.5 ECOLOGICAL RISK ASSESSMENT

11.5.0.1. This section discusses the results of the ecological evaluations for SWMU 34. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4. As described in the following paragraphs, SWMU 34 has little to support ecological receptors; therefore, the pathways on the conceptual model are incomplete.

11.5.1. Tier 1

11.5.1.1. Ecological Receptors. This SWMU is in the Administration Area of the TEAD-N facility and is surrounded by buildings, asphalt roads, some landscape plantings, and a few open areas with native vegetation. A railroad track runs along the east side of the SWMU. Most open areas appear to have been disturbed by past grading, mowing, or storage. Dead rubber rabbitbrush, possibly the result of herbicide application, are scattered in this area. A few scattered kochia are growing between cracks in the asphalt. There is no vegetation community that can be described for this SWMU.

11.5.1.2. Wildlife. No animal sign was observed at this SWMU. There is a possibility that the common house mouse may occur sporadically throughout the area. No rabbit pellets were observed, but black-tailed jackrabbits have been observed previously in and around the nearby Maintenance Area (personal communication, Dr. J. Merino). It is

likely that rabbits move through this area, since there is no habitat to support wildlife at this SWMU.

11.5.1.3. Results of the Tier 1 Ecological Assessment. The field surveys indicate that there are no significant ecological receptors that would be impacted by the chemicals detected at SWMU 34. Therefore, no Tier 2 ecological assessment will be conducted for this SWMU.

11.5.2. Recommendations

11.5.2.1. Based on the preceding discussions, SWMU 34 is recommended for no further investigation regarding potential ecological effects.

12.0 CONTAMINATED WASTE PROCESSING PLANT (SWMU 37)

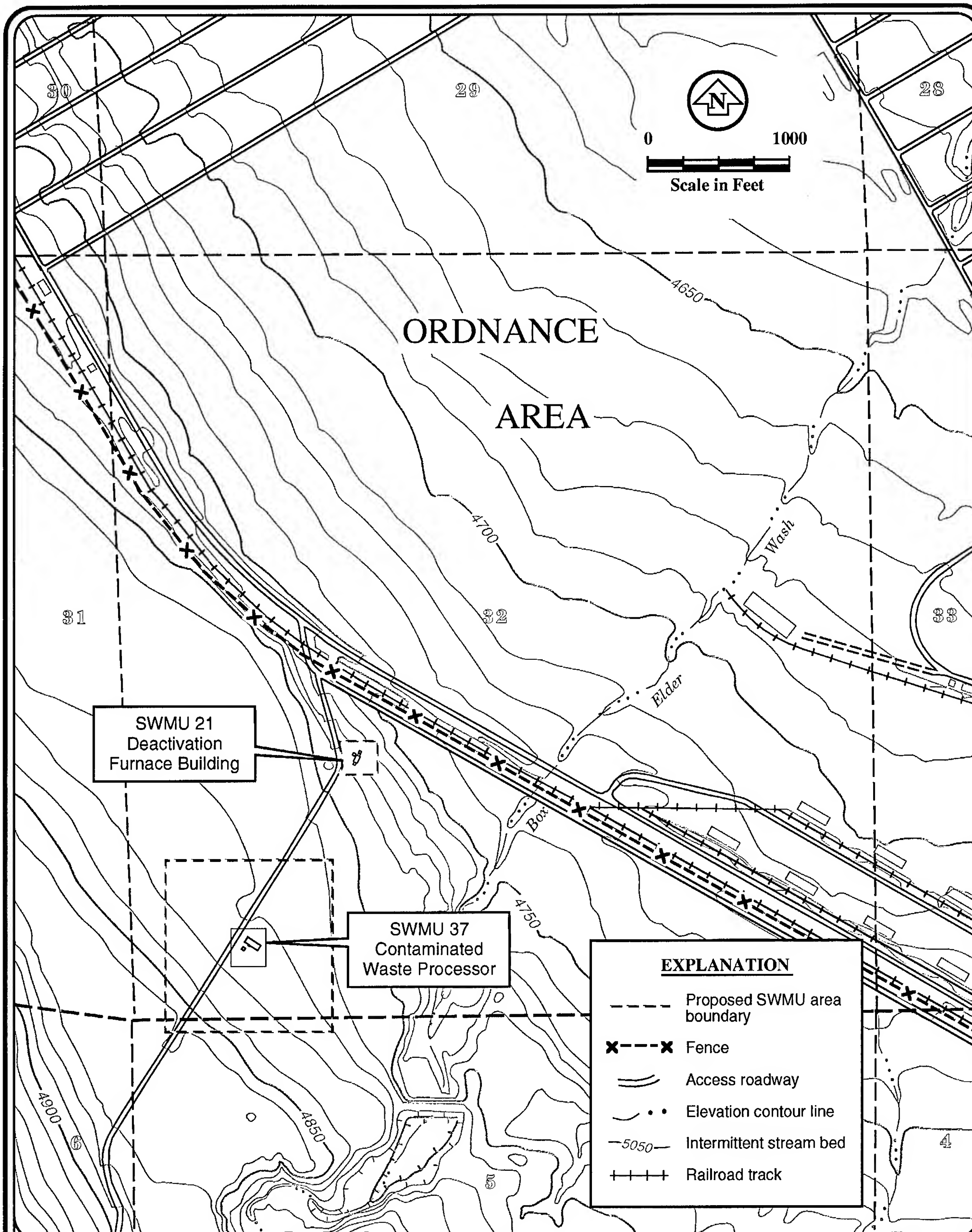
12.1 SITE BACKGROUND

12.1.0.1. Site Description. The Contaminated Waste Processing Plant (CWP) is an incinerator located in the southwestern portion of TEAD-N, southwest of the ordnance area (Figure 12-1). The CWP consists of one large building (Building 1325), another smaller storage building, and adjacent staging and storage areas. The furnace is fired by diesel oil from an underground storage tank located south of the building. A propane tank is also present at SWMU 37. The facility itself, including the surrounding paved staging areas, is about 150 feet by 125 feet in size (about 0.5 acre). A 4-foot high barbed wire fence surrounds the facility. In 1990, an inspection by the Utah Department of Environmental Quality revealed that the CWP was being used to conduct test burns of materials containing traces of hazardous wastes for which it was not permitted. As a result of the inspection, the CWP was ordered closed while the Army seeks State approval to restart the operation.

12.1.0.2. Operational Activities. Since its installation in approximately 1980 and until it was closed in 1990, the CWP has been used primarily for flashing scrap metal and incinerating PCP-treated wooden crates, general packaging materials (dunnage), scrap resins, and fabric contaminated with explosives (Bishop, 1990). This furnace differs from the furnaces at the AED Deactivation Furnace Site (SWMU 20) and the Deactivation Furnace Building (SWMU 21) in that it is a batch-type basket furnace rather than a rotary kiln. In addition, the CWP is not used for deactivating munitions. Air pollution control equipment, installed during construction of the furnace, consists of a cyclone, gas cooler, and baghouse.

12.1.0.3. When the CWP is operating, all metal debris are certified as clean and sent to the DRMO Storage Yard (SWMU 26) for salvage. Incinerator ash, cyclone dust, and baghouse dust are drummed as hazardous waste and sent to the 90-day Storage Yard (SWMU 28) pending analysis and disposal.

12.1.0.4. Geology and Hydrology. The soils which underlie the CWP are composed of sands and silty sands (Jordan, 1989) of the Berent soil type, described as loamy fine sand and fine sand (eolian sands), and are part of the Berent-Hiko Peak Complex. Soil permeability of the Berent soils is rapid, ranging from 4.2×10^{-3} to greater than 1.4×10^{-2} cm/sec (USSCS, 1991). Much of the ground surface around the CWP is paved and



Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 37
CONTAMINATED WASTE PROCESSOR
LOCATION MAP
FIGURE 12-1

surface water runs off toward the northeast. The depth of bedrock is approximately 500 feet bgs (ERTEC, 1982). The depth to groundwater is approximately 450 feet, and the direction of flow is toward the northeast (JMM, 1988).

12.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

12.2.1. Previous Investigations

12.2.1.1. Previous investigations at the CWP were limited to analyses of cyclone/baghouse dust and/or incinerator ash. Analyses of these wastes indicated that concentrations of lead and cadmium both exceeded the threshold for characterizing a waste as hazardous based on toxicity (Bishop, 1990). In addition to the metals, dioxins and furans were found in ash and dust in the air pollution control system after burning pentachlorophenol (PCP)-treated wood (AEHA, 1989). Although the presence of dioxins and furans has been confirmed in the PCP-treated wood prior to incineration, it appears that the incineration process also produces dioxins and furans. While the total levels of PCPs were high in the ash and dust, there were no detectable concentrations of PCP in the TCLP extracts (AEHA, 1989).

12.2.2. RFI Sampling Summary

12.2.2.1. Phase I Sampling. During Phase I RFI sampling in July 1992, 12 surface soil samples were collected from locations around the perimeter of the facility from areas with exposed soil immediately adjacent to the building and paved areas. Sample locations were sited to give general coverage around the perimeter of Building 1325 and associated paved areas, with the objective of establishing the presence or absence of contamination from this site. The majority of these surface soil samples were located along the edges of the asphalt in areas that would receive stormwater runoff. All samples were analyzed for metals, VOCs, SVOCs, dioxins/furans, and explosives.

12.2.2.2. Phase II Sampling. Phase II sampling activities were conducted to define the degree to which contaminants detected by the Phase I sampling had migrated away from the facility. This included contaminant migration away from SWMU 37 via surface and air pathways (lateral extent) and infiltration to depth by contaminants (vertical extent). The following sampling activities were conducted:

- Seven shallow boreholes were hand-augered at locations where elevated metals, SVOCs, and/or dioxins/furans were previously detected to provide information on the vertical infiltration of contaminants. Three samples were collected from each hand boring (21 samples total) and submitted for SVOC and dioxins/furans analyses. One of these borings was located adjacent to an oil/water separator to investigate the possibility of spills or overflows. Another boring was completed next to a sanitary system holding tank northeast of Building 1325.

- Eight surface soil samples were collected 500 feet from the facility in the north, northeast, east, southeast, south, southwest, west, and northwest directions. These samples were collected to investigate the areal extent of contamination originating from SWMU 37, and were analyzed for SVOCs and dioxins/furans.

- To provide additional data for the background database, two 3-foot deep borings were hand augered at locations over 1,000 feet distant from the SWMU 37 facility, and two samples submitted from each boring for total metals analysis.

12.2.2.3. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that all of the SWMU 37 data are usable. Di-n-butylphthalate was qualified as not detected in 16 soil samples by Montgomery Watson chemists due to method blank contamination. Additionally, one soil sample had three SVOCs qualified as estimated by Montgomery Watson chemists due to MS/MSD precision nonconformances. However, no data for this SWMU were rejected; therefore, 100 percent completeness was achieved. Further details concerning the data review are presented in Appendix E of this document.

The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviation and DQOs were met. Due to this, no data gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

12.3 CONTAMINATION ASSESSMENT

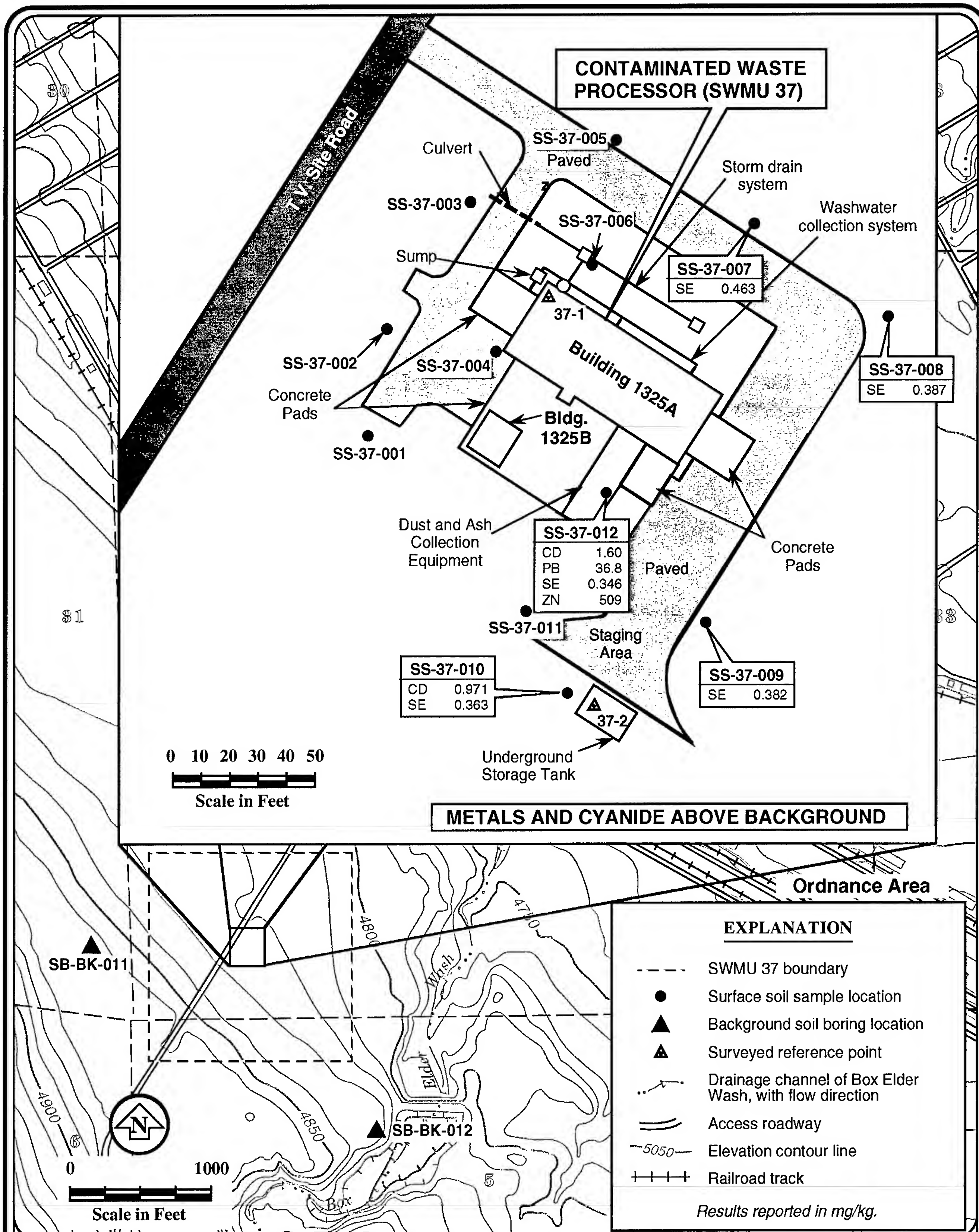
12.3.1. RFI Sampling Results

12.3.1.1. Contaminants detected by the RFI sampling program at SWMU 37 include elevated levels of four metals, several dioxin/furan compounds, SVOCs, 2,4,6-TNT, and elevated nitrate and total phosphate.

12.3.1.2. Surface Soils. Various types of contaminants have been released to the surface soils at SWMU 37. Elevated levels of metals were detected in five of the 12 surface soil samples collected during Phase I sampling. The concentrations were generally low (less than two times the background thresholds) (Figure 12-2). Elevated metals detected include cadmium, lead, selenium, and zinc. Of these metals, only zinc was elevated significantly, at eight times the background threshold. No metals were detected that exceed available risk-based soil guidance thresholds for either commercial or residential scenarios (USEPA, 1994a).

12.3.1.3. Detectable levels of dioxins/furans were present in 12 of the 20 soil samples collected from surface soils at this SWMU (Figure 12-3). Additionally, dioxins/furans were also detected in six of the seven shallow boreholes in the surface interval (0 to 1-foot bgs). Concentrations of the dioxins and furans detected were generally low (less than 1 ppb) with several exceptions, which ranged up to 47 ppb for the OCDD isomer. Only two samples, collected from the same area, contained detectable concentrations (0.0002 mg/kg and 0.0001 mg/kg) of the most toxic dioxin isomer 2,3,7,8-TCDD. The following summary compares the results for the dioxin compounds TCDD and HXCDD in the surface soils at SWMU 37 with the available risk-based soil guidance thresholds for these compounds. These guidance thresholds are used only for comparison purposes in this report (USEPA, 1994a). Only these two dioxin compounds have established thresholds at this time.

Analyte	Residential Threshold (mg/kg)	No. of Detections Exceeding Residential Threshold	Industrial Threshold (mg/kg)	No. of Detections Exceeding Industrial Threshold	Maximum Concentration Detected (mg/kg)
2,3,7,8-TCDD (tetrachlorodibenzodioxin)	0.000008	2	0.000019	2	0.0002
HXCDD (hexachlorodibenzodioxin mixture)	0.00019	5	0.00046	2	0.0059



Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 37
CONTAMINATED WASTE PROCESSING PLANT
ANALYTICAL RESULTS FOR SURFACE SOILS
FIGURE 12-2

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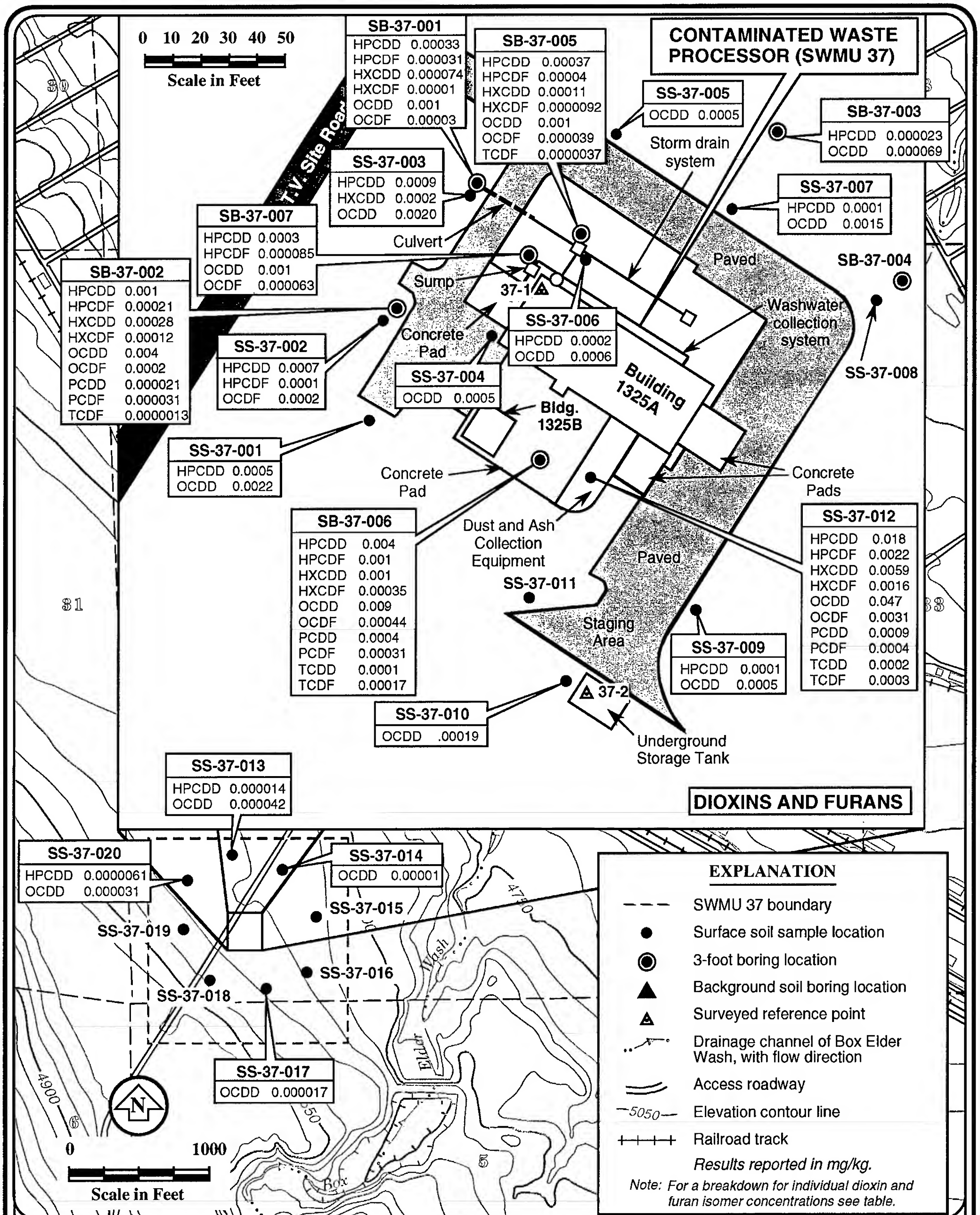

Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs

SWMU 37

CONTAMINATED WASTE PROCESSING PLANT ANALYTICAL RESULTS FOR SURFACE SOILS

FIGURE 12-3

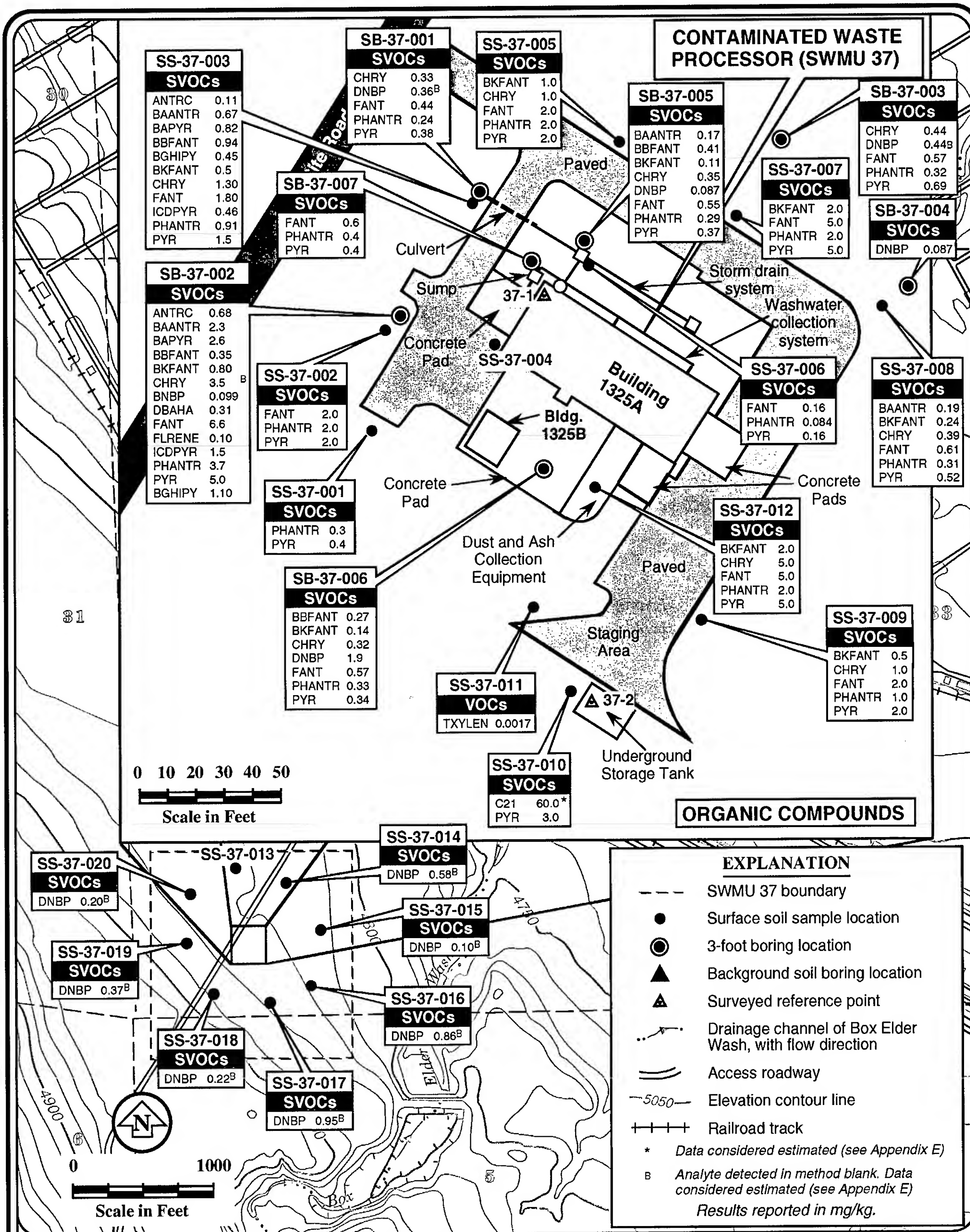
PROJECT NO. 2942.0190 10/23/95

12.3.1.4. Numerous SVOCs and one VOC were detected in 18 of the 20 surface soil samples collected, ranging in concentrations from 0.1 mg/kg to 60.0 mg/kg. The majority of detections were less than 1 mg/kg for these analytes. The SVOCs detected consisted mainly of PAHs which are commonly found in incinerator ash. Fuel spills or overflows related to the UST in the southern part of the facility are probably responsible for detections of total xylenes and heneicosane (a 21-carbon hydrocarbon) in two surface soil samples nearby. Figure 12-4 shows the detections of organic compounds in the surface soils at SWMU 37.

12.3.1.5. The compound 2,4,6-TNT was detected at a concentration of 0.515 mg/kg in one surface soil sample collected during Phase I sampling. This was the only explosive compound detected here. Seven of the Phase I surface soil samples showed elevated levels of nitrates and/or total phosphates. Figure 12-5 shows the concentrations of explosives and anions detected in the surface soils. Neither explosives nor anions were analytes of concern for the Phase II sampling at SWMU 37.

12.3.1.6. Shallow Subsurface Soils. Dioxin/furan compounds were detected in the shallow subsurface soils in four of the seven auger holes completed at SWMU 37. Detections of these compounds were seen down to 2 feet bgs in all four of these boreholes and down to 3 feet bgs (total depth) in three of them. The most common dioxin isomers detected were heptachlorodibenzodioxin (HPCDD) and octachlorodibenzodioxin (OCDD). One detection of the more toxic isomer tetrachlorodibenzodioxin (TCDD) was seen in the 2 to 3 feet bgs interval of one auger hole, SB-37-006. This detection, at 0.031 ppb, exceeds the available risk-based guidance threshold for TCDD of 0.019 ppb for commercial/industrial soils (USEPA, 1994a). This soil boring, which also detected TCDD at a concentration of 0.0001 mg/kg in the surface interval, was located immediately south of Building 1325 in an area that receives stormwater runoff from an adjacent concrete equipment pad and also from an adjacent asphalt-covered surface. Figure 12-6 shows the subsurface detections of dioxin/furan compounds.

12.3.1.7. Several SVOC compounds were detected in the shallow subsurface soils as shown in Figure 12-7. Five auger holes showed detections of these SVOCs down to 3 feet bgs, four of which also showed dioxin/furan compounds to depth, as previously mentioned. The most common of these detections was the phthalate compound di-n-



Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 37
CONTAMINATED WASTE PROCESSING PLANT
ANALYTICAL RESULTS FOR SURFACE SOILS
FIGURE 12-4

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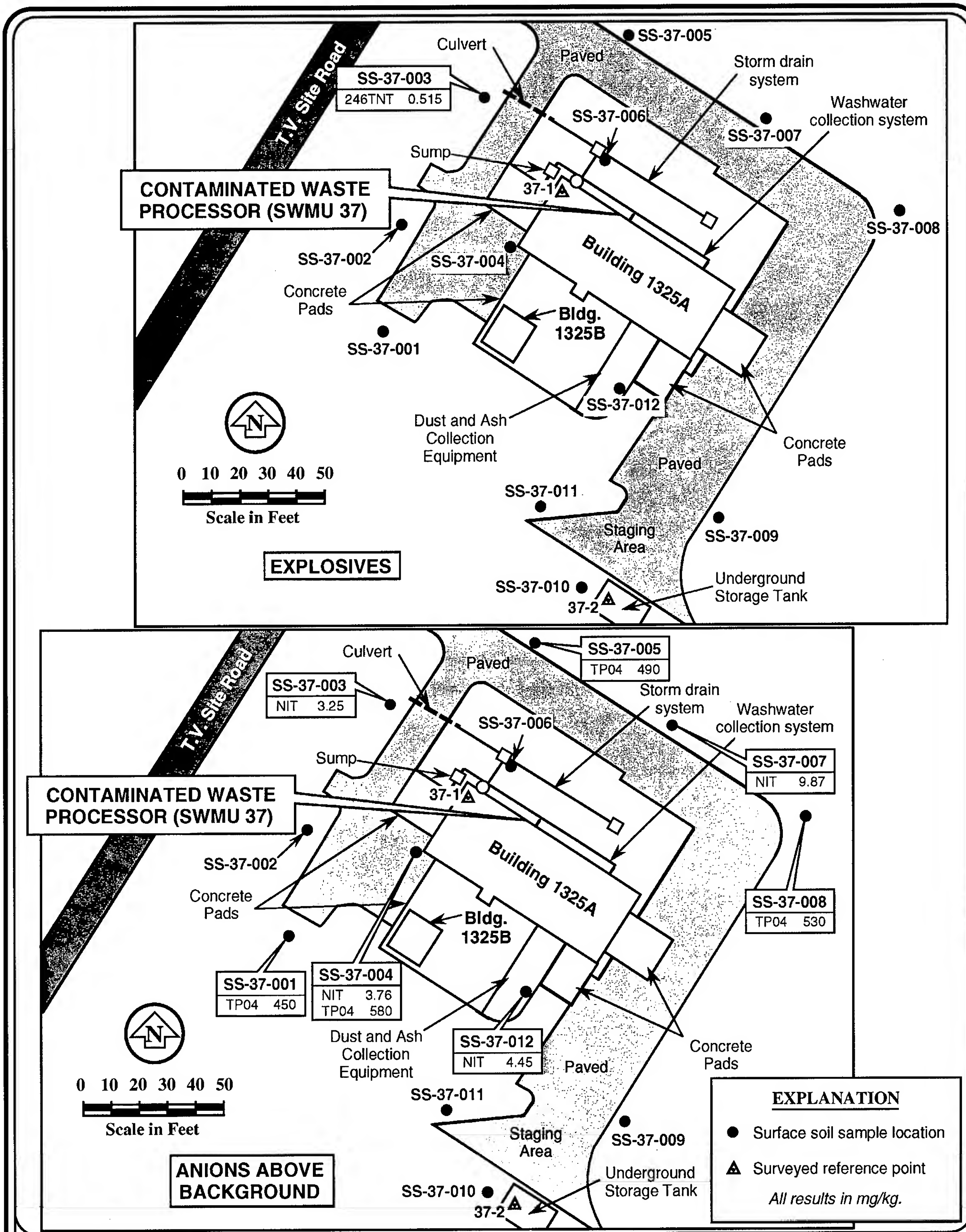

Source: Modified from USGS Grantsville 7.5 minute quadrangle.

TEAD-N RFI—GROUP A SWMUs

SWMU 37

CONTAMINATED WASTE PROCESSING PLANT ANALYTICAL RESULTS FOR SURFACE SOILS

FIGURE 12-5

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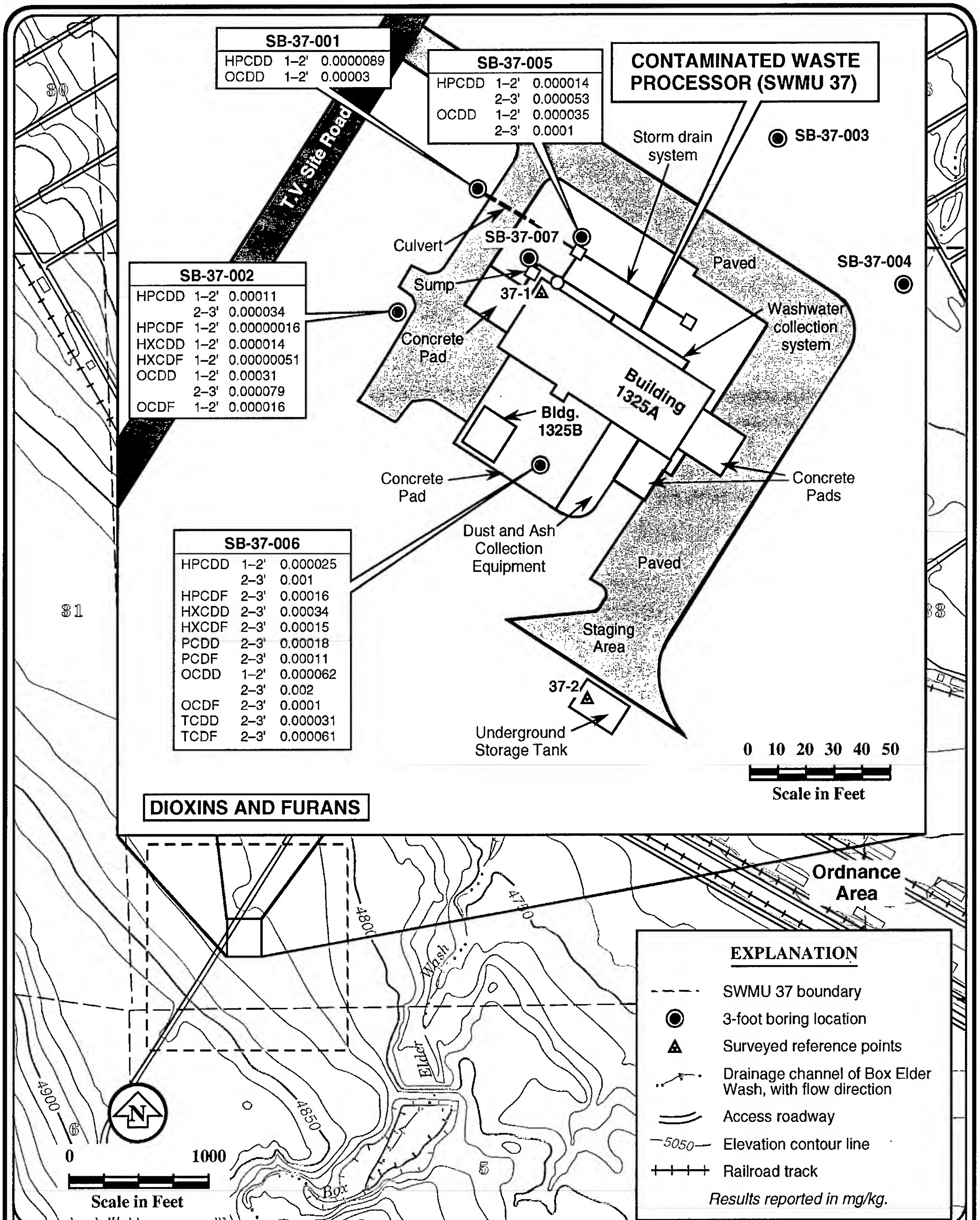

Source: Modified from USGS Grantsville 7.5 minute quadrangle.

TEAD-N RFI—GROUP A SWMUs

SWMU 37

CONTAMINATED WASTE PROCESSING PLANTANALYTICAL RESULTS FOR SHALLOW SUBSURFACE SOILS

FIGURE 12-6

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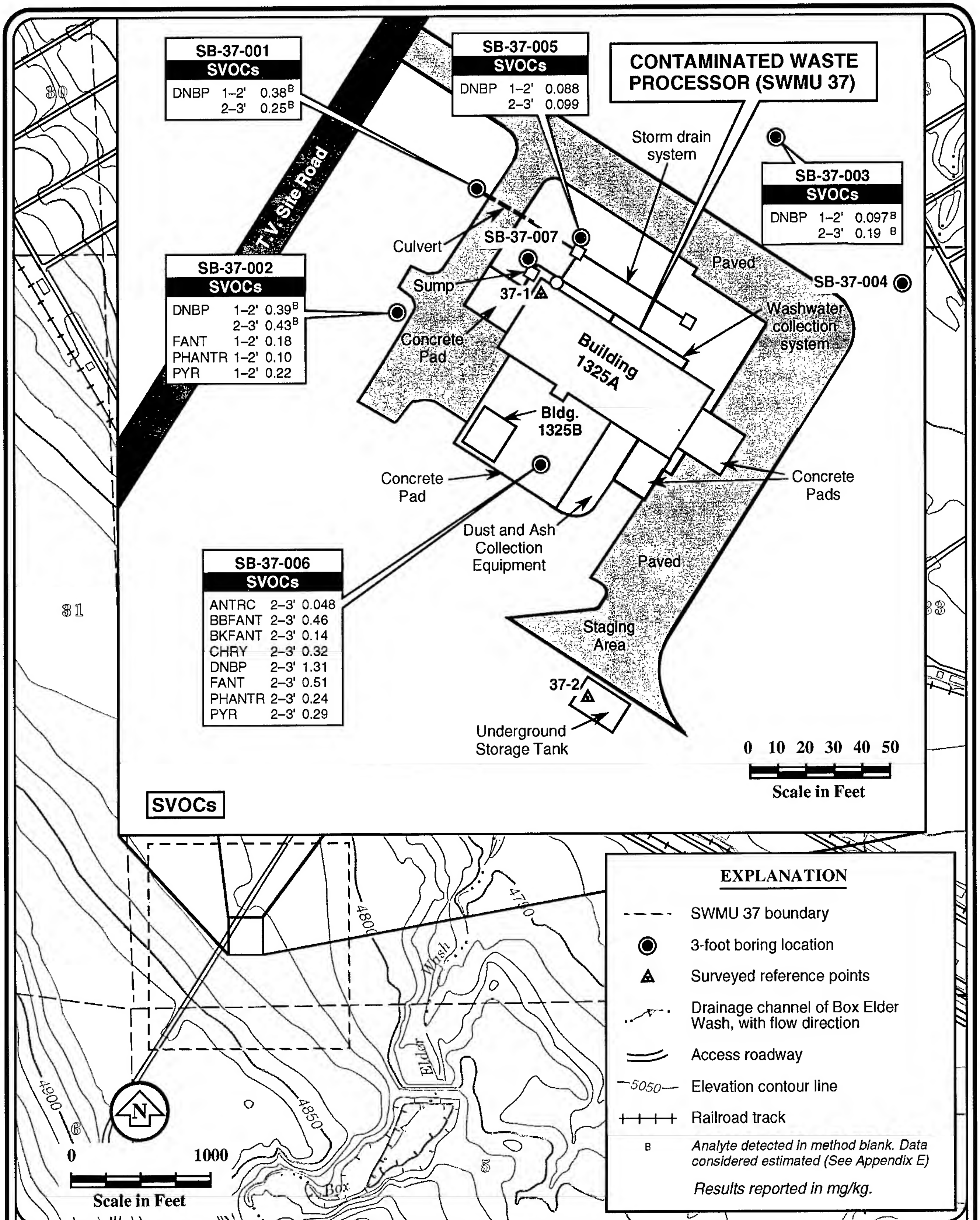

Source: Modified from USGS Grantsville 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 37
CONTAMINATED WASTE PROCESSING PLANT
ANALYTICAL RESULTS FOR SHALLOW SOILS
FIGURE 12-7

PROJECT NO. 2942.0190 10/23/95

butyl phthalate (DNBP), which was detected in all five of these auger holes. Concentrations of the detected SVOCs ranged up to 0.51 mg/kg.

12.3.2. Nature and Extent of Contamination

12.3.2.1. The results of the RFI sampling programs at SWMU 37 showed that several types of contaminants have been released to the surrounding surface and shallow subsurface soils. The metals, explosives, and VOCs (xylene) detected during Phase I sampling did not show either the concentrations or extent to warrant further Phase II sampling. However, dioxin/furan compounds and SVOCs were detected consistently in the surface soils immediately surrounding Building 1325, and two dioxin compounds exist at low levels out to at least 500 feet from the facility. The most probable transport mechanism for these compounds is deposition from incinerator stack emissions.

12.3.2.2. Some migration of dioxins/furans to the subsurface has occurred, mainly in areas where stormwater runoff collects from surrounding paved or concrete pad surfaces. The depth to which these contaminants have migrated has not been completely defined since detections persist to total depth in three of the auger holes. The sandy, permeable soils at SWMU 37 tend to allow subsurface migration of contaminants, especially where stormwater tends to collect and infiltrate.

12.3.2.3. The distribution of the SVOCs detected at SWMU 37 follows that of the dioxins/furans. The surface soils in the immediate vicinity of Building 1325 show numerous detections of SVOCs, mainly PAHs. One phthalate compound was detected in 50 percent of the surface soil samples at a distance of 500 feet from the facility. Subsurface detections of SVOCs were seen in the same areas showing dioxins/furans at depth (i.e., areas of ponding stormwater runoff). As with the dioxins/furans, the vertical extent of SVOC contaminants has not been completely defined in these areas.

12.3.3. Selection of COPCs and COPECs

12.3.3.1. Identification of COPCs. The selection of the COPCs for the Contaminated Waste Processing Plant (SWMU 37) was based on the screening procedures outlined in Section 3.2.6. A summary of all chemicals detected in samples from SWMU 37, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationale for the analytes not selected as COPCs are shown in Table 12-1.

TABLE 12-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN
FOR ANALYTES DETECTED IN SOIL AT SWMU 37–CONTAMINATED WASTE PROCESSING PLANT

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluate in Risk Assessment	
			Human	Ecological
Aluminum	3.44E+03	100	No(a)	No(a)
Arsenic	6.96E+00	100	No(a)	No(a)
Barium	7.76E+01	100	No(a)	No(a)
Beryllium	6.32E-01	25	No(a)	No(a)
Cadmium	**1.60E+00**	**17**	**Yes**	No(e)
Chromium	1.16E+01	75	No(a)	No(a)
Cobalt	2.68E+00	100	No(a)	No(a)
Copper	1.49E+01	100	No(a)	No(a)
Lead	3.68E+01	100	No(f)	No(a)
Manganese	1.90E+02	100	No(a)	No(a)
Nickel	8.55E+00	100	No(a)	No(a)
Selenium	**4.63E-01**	**42**	**Yes**	No(e)
Vanadium	1.03E+01	100	No(a)	No(a)
Zinc	5.09E+02	100	No(b)	**Yes**
2,4,6-Trinitrotoluene	**5.15E-01**	**8**	**Yes**	**Yes**
Anthracene	7.00E-01	7	No(c)	No(e)
Benzo[g,h,i]perylene	**1.10E+00**	**5**	**Yes**	No(e)
Di-n-butylphthalate	1.00E+00	54	No(c)	No(e)
Dioxins/Furans	**6.13E-05(d)**	**58**	**Yes**	No(e)
Fluoranthene	**6.60E+00**	**39**	**Yes**	No(e)
PAHs (carcinogenic)	**5.52E+00**	**31**	**Yes**	No(e)
Phenanthrene	**3.70E+00**	**41**	**Yes**	No(e)
Pyrene	**5.00E+00**	**44**	**Yes**	No(e)
Xylenes	2.00E-03	8	No(c)	No(c)

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium
Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

PAHs Polyaromatic hydrocarbons
(a) Analyte was detected at or below background concentrations
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte contributed less than 1 percent in a concentration - toxicity screen
(d) Concentration based on toxicity equivilance factors
(e) Maximum concentration less than NOAEL or estimate of NOAEL
(f) Based on recent EPA policy indicating that lead concentrations below 400 mg/kg do not require remediation area in a residential setting

12.3.3.2. Chemicals of potential concern selected for the human health risk assessment at SWMU 37 include the metals cadmium and selenium (note that lead was present at background concentrations, and is therefore not a COPC at SWMU 37). Organic chemicals of potential concern include dioxins/furans, 2,4,6-TNT, the carcinogenic PAHs benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, and indeno[1,2,3-c,d]pyrene, and the noncarcinogenic PAHs benzo[g,h,i] perylene, fluoranthene, phenanthene, and pyrene. The selection of COPCs was in accordance with the methodology outlined in Section 3.2.6.

12.3.3.3. Identification of COPECs. The COPECs at SWMU 37, zinc and 2,4,6-TNT, were selected based on the criteria outlined in the methodology discussion (Section 3.2.7.). The COPECs that are evaluated in Tier 2 and the reason for the exclusion of analytes from further evaluation are presented in Table 12-1.

12.3.4. Contaminant Fate and Transport

12.3.4.1. As discussed in section 12.3.3. the contaminants of concern at SWMU 37 include metals (cadmium and selenium), an explosive compound (2,4,6-TNT), dioxins, furans and PAHs (Table 12-1). Table 3-4 briefly describes the fate and transport characteristics for each of the contaminants of concern identified in Table 12-1. The remainder of this section will present a conceptual model of contaminant fate and transport at SWMU 37 and discuss the expected fate and transport of the contaminants of concern.

12.3.4.2. Conceptual Model. A conceptual site model of contaminant transport (Figure 12-8) has been developed based on the physical site characteristics presented in Section 2.0 and the contamination assessment presented above. This model displays the potential routes of migration of contaminants from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear unlikely based on available data. Contamination at SWMU 37 has been released to the surface soils, probably from stack emissions and surface spills of incinerator residue. The surface soils and shallow soils at SWMU 37 consist of sands and silty sands, and much of the area is paved. Surface runoff is toward the northeast and the depth to groundwater is approximately 450 feet bgs.

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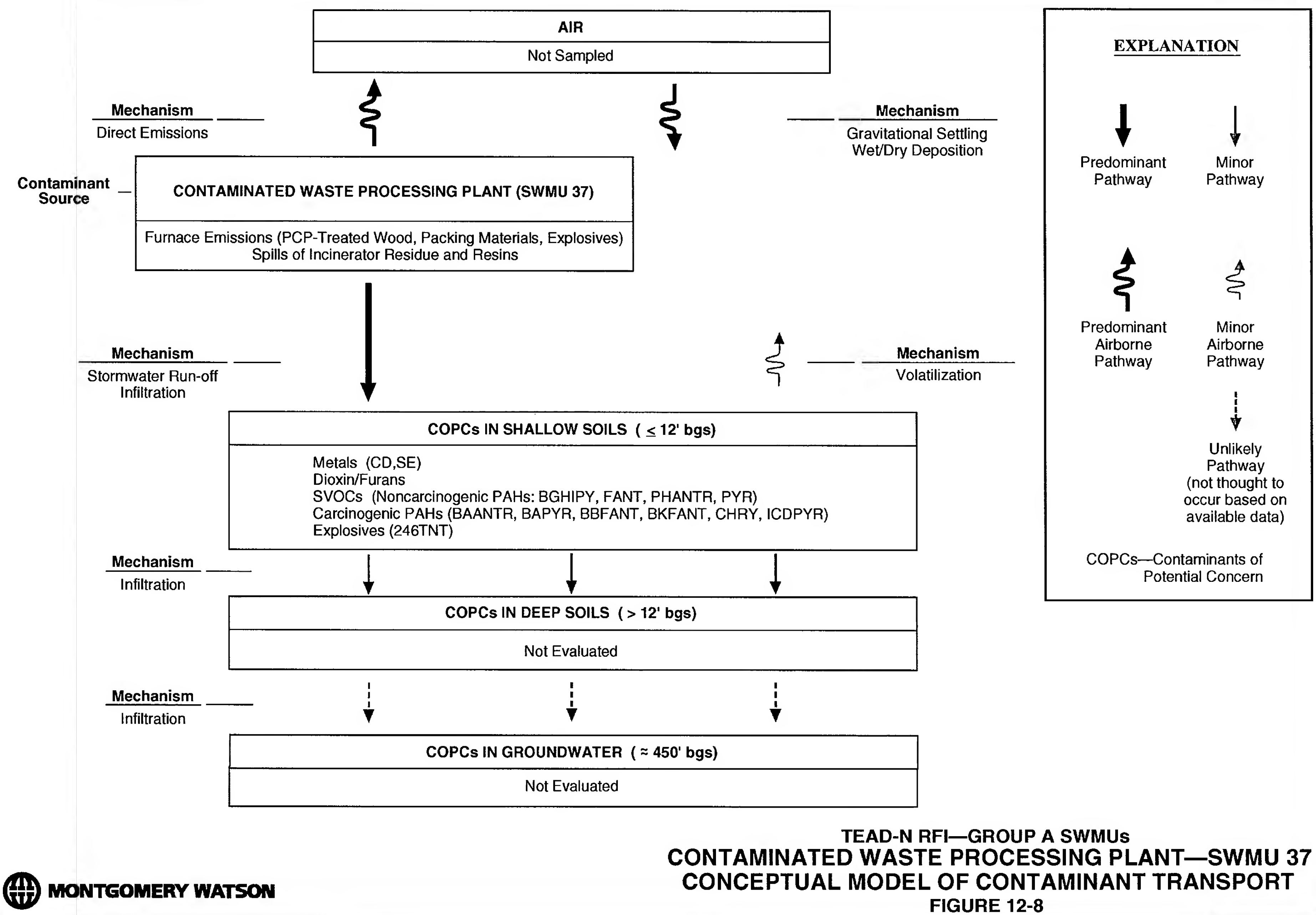

TEAD-N RFI—GROUP A SWMUs
CONTAMINATED WASTE PROCESSING PLANT—SWMU 37
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 12-8

12.3.4.3. Fate and Transport of Metals. Based on the low concentrations of the metals of concern (< 2 mg/kg) and other site conditions, it is unlikely that metals will migrate to the groundwater or even to deeper soil horizons. The transport potential of metals is very low here because of the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow soils, neutral to slightly basic pH soils, and the depth to groundwater (more than 450 feet below the ground surface). Off-site migration of metal contaminants via a surface water pathway is expected to be minimal based on the low concentrations of these contaminants in the source areas. The metal contaminants at the surface are not expected to provide significant quantities of particulates to the air pathway.

12.3.4.4. Fate and Transport of Explosives. Only one explosive compound was detected in a surface sample at SWMU 37. Even though explosive compounds are generally mobile in the environment it is not expected that this explosive is at a high enough concentration to be transported more than a few feet down the soil column. Attenuation of this explosive with time would be expected through slow volatilization to the atmosphere and/or by slow photolytic transformations at the surface.

12.3.4.5. Fate and Transport of Dioxins and Furans. Several dioxin and furan compounds have been detected at SWMU 37 at the surface and in the shallow subsurface (down to 3 feet bgs). Because the geology at this site consists of abundant fine-grained particles (mostly silty sands), the dioxins and furans are expected to strongly adsorb to the soil and be immobile. There is little potential for these compounds to leach under normal environmental conditions. Surface water runoff will have only local transport effects (i.e., only effective in the areas adjacent to the pavement and to the storm drain discharge area) because these contaminants will strongly adsorb to sediments and precipitation rates are low. Dioxins that have been identified in low concentrations as far as 500 feet away from the probable source are likely to have been transported as stack emissions (see Paragraph 12.3.2.1.). The contaminants at the surface may provide particulates to the air pathway. Dioxins and furans are expected to be persistent in the environment.

12.3.4.6. Fate and Transport of PAHs. Table 3-4 briefly describes the fate and transport characteristics of PAHs. Typically, PAHs will strongly adsorb to soils and will resist leaching to deeper soil horizons and to groundwater as indicated by their high K_{OC} partitioning coefficient. Leaching to groundwater is highly unlikely at SWMU 37 because of the immobility of PAHs in the soil and the large vertical distance to

groundwater (about 450 feet). Low molecular weight PAHs (such as anthracene and fluoranthene) tend to slowly volatilize from surface soils. The medium to high molecular weight PAHs have only limited volatilization potential and will likely not attenuate in the surface or shallow soils by this process. All PAH contaminants may adsorb to particulates and be transported via the air pathway where they may photodegrade or oxidize and be removed by wet/dry deposition. PAHs are also expected to be slowly attenuated in surface and subsurface soils by biodegradation processes.

12.4 HUMAN HEALTH RISK ASSESSMENT

12.4.0.1. The methods used to estimate the risks associated with SWMU 37 are given in the Human Health Risk Assessment Methodology, Section 3.2.6. The COPCs were identified in the previous section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 37) are presented in the following sections.

12.4.1. Exposure Pathways and Receptors

12.4.1.1. The pathways quantitatively evaluated in the BRA are: 1) those that are complete or likely to be completed in the future, and 2) those that may potentially cause a significant risk. An evaluation of completeness is shown on an exposure pathways diagram for SWMU 37 (Figure 12-9). An evaluation of pathway completeness and an assessment of the whether a pathway is significant enough to require further evaluation for current and potential future receptors at SWMU 37 is given in Tables 12-2 and 12-3, respectively.

12.4.1.2. Current on-Depot receptors are the civilian Depot personnel who work at SWMU 37. The kiln at SWMU 37 is presently inactive but could resume operations at any time. When the waste processor is operated, up to four workers load and unload the kiln ten hours per day, four days per week. Other receptors include a surveillance person and an occasional millwright for maintenance. The evaluation of Depot personnel assumed that the CWP was operating at full capacity. The Depot personnel working at SWMU 37 may have incidental ingestion, dermal, and inhalation exposure, primarily via dust.

12.4.1.3. Potential future on-Depot receptors for contaminants originating from SWMU 37 include construction workers and TEAD-N residents. Construction workers may be

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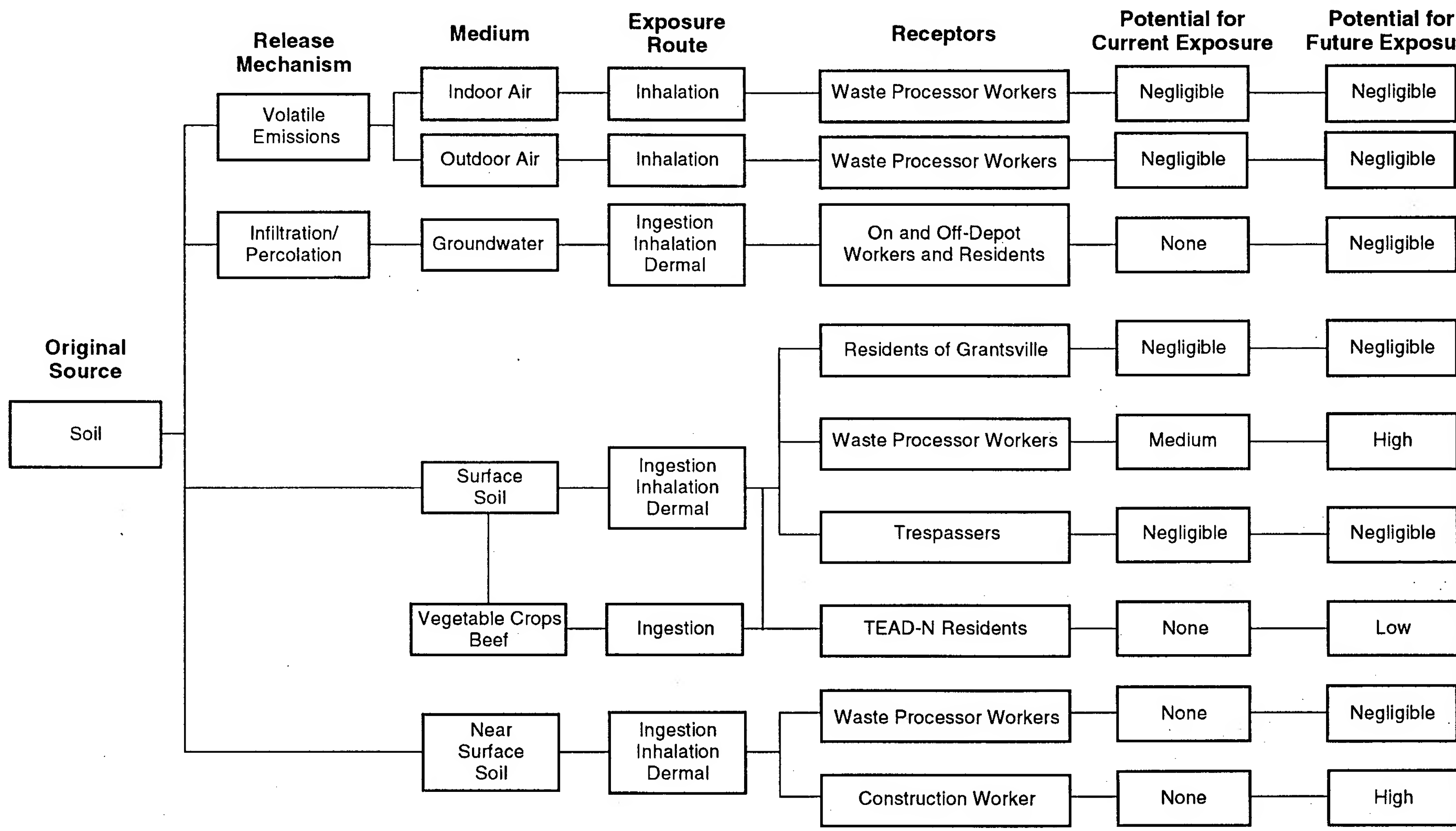

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TEAD-N RFI—GROUP A SWMUa
CONTAMINATED WASTE PROCESSING PLANT—SWMU 37
EXPOSURE PATHWAYS DIAGRAM
FIGURE 12-9

TABLE 12-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 37: CONTAMINATED WASTE PROCESSING PLANT

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is estimated to be 350 feet below the below ground surface, evapotranspiration is high, and primary contaminants (i.e. semi-volatile organics and dioxins/furans) have low mobility.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 37 is small and the amount of dust in Grantsville originating from SWMU 37 will be miniscule.
	Waste processor workers	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil is contaminated and Depot personnel may frequent the site.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers have not been observed at this area.
Near-Surface Soil	Waste processor workers	Incidental ingestion of dust, inhalation, and dermal contact	No. Personnel activity patterns do not include intrusive activities such as excavation.
Air	Waste processor workers	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure is evaluated under soil.

TABLE 12-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 37: CONTAMINATED WASTE PROCESSING PLANT

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely result in the future. Groundwater is estimated to be 350 feet below the below ground surface, evapotranspiration is high, and primary contaminants (i.e. semi-volatile organics and dioxins/furans) have low mobility.
Soil Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 37 is small and the amount of dust in Grantsville originating from SWMU 37 will be miniscule.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil is contaminated and while not expected due to the isolation of this SWMU, a future residential land use cannot be ruled out.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers are not expected and the exposure will be less than for a future resident.
Near-Surface Soil	Construction workers	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Shallow soil is contaminated and future construction is possible.
Air	Future TEAD-N residents	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure is evaluated under soil.

exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For construction workers, direct exposure results from the anticipated excavation activities associated with construction or demolition of a building, and includes both surface and subsurface soil. Should this portion of the Depot be closed in the future (it is not slated for closure at this time), residents could become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. It should be noted that a residential development is unlikely even if the Depot is closed because SWMU 37 is in a remote area. However, because of the requirements of UAC 315-101 (1994), a residential scenario was evaluated.

12.4.1.4. SWMU 37 could be converted into an area where crops are grown. However, efforts to grow vegetables in soil from adjacent areas failed (Rust E&I, 1995). The experiments included soil from an area where there was no known release of hazardous chemicals. It was concluded that the salt content of the soil was "toxic", and that vegetables could not be grown without leaching salt from the soil. Although such activities are considered unlikely, this pathway is evaluated as part of the future residential scenario.

12.4.1.5. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. This pathway is also evaluated as part of the future residential scenario.

12.4.1.6. For the pathways that were quantitatively evaluated (see Tables 12-2 and 12-3), site-specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are presented in Appendix K.

12.4.2. Risk Characterization

12.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 37. The methods for risk calculation are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are presented in Appendix K.

12.4.2.2. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable, a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or

the potential for pathway completeness is minimal), and a risk between these two values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one indicates that adverse health effects are possible. An adult blood lead level between 10 and 15 micrograms per deciliter (μg/dl) is a benchmark range based on hypertension in adult males and transfer of lead from a pregnant mother to her fetus. For children, 10 μg/dl is the benchmark typically used by the EPA (USEPA, 1994; see Section 3.2.6. for a discussion of the calculation of blood lead concentrations for adults and children).

12.4.2.3. In addition to the calculated estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for current Depot personnel, and potential future construction workers and residents.

12.4.2.4. Waste Processor Workers. As shown in Table 12-4, the excess lifetime cancer risk for Depot personnel working at SWMU 37 was estimated to equal 1×10^{-5}. The majority of the cancer risk calculated is generated by dermal and ingestion exposure to carcinogenic PAHs and, to a lesser extent, dioxins/furans. The cancer risk is in a range where qualitative factors play the greatest part in determining whether the risk is significant or not. The significance of the pathway is increased by the fact that the pathway has a high probability of being completed. Factors that may underestimate the dermal cancer risk estimate include the dermal absorption and toxicity of PAHs. Parameters tending to overestimate the dermal cancer risk include biasing the exposure point concentration high by sampling the areas most likely to be contaminated, assuming a person works at one job in one location for 25 years, and assuming that all exposed skin will be covered with soil (see the discussion of uncertainties in Section 12.4.3). While unlikely to be an underestimate, the dermal cancer risk of 7×10^{-6} is not necessarily a large overestimate.

12.4.2.5. The ingestion risk is likely an overestimate based on likely overestimates in the ingestion rate and the exposure duration. The absence of inhalation slope factors for carcinogenic PAHs and 2,4,6-TNT results in an underestimate of the inhalation risk. However, by assuming that the inhalation slope factor equals the oral slope factor (which

TABLE 12-4

SWMU 37 - CONTAMINATED WASTE PROCESSING PLANT
RME CANCER RISK AND HAZARD INDEX
FOR WASTE PROCESSOR WORKERS

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	9.8E-01	NC	NC	4E-11	4E-11	<1
Dioxins/Furans	2.3E-05	6E-07	9E-07	2E-11	2E-06	16
Carcinogenic PAHs	1.8E+00	2E-06	6E-06	NC	8E-06	84
2,4,6-Trinitrotoluene	5.0E-01	3E-09	4E-09	NC	7E-09	<1
Pathway Total		3E-06	7E-06	7E-11		
Percent of Total		30	70	<1		
				Total Cancer Risk	**1E-05**	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Cadmium	9.8E-01	5E-04	3E-04	NC	8E-04	32
Selenium	3.7E-01	4E-05	2E-06	NC	4E-05	2
2,4,6-Trinitrotoluene	5.0E-01	5E-04	8E-04	NC	1E-03	54
Benzo[g,h,i]perylene	1.1E+00	2E-05	5E-05	NC	6E-05	3
Fluoranthene	1.7E+00	2E-05	5E-05	NC	8E-05	3
Pyrene	1.6E+00	3E-05	7E-05	NC	9E-05	4
Phenanthrene	9.5E-01	2E-05	4E-05	NC	6E-05	2
Pathway Total		1E-03	1E-03	NC		
Percent of Total		46	54	NC		
				Total Hazard Index:	**2E-03**	
				Blood Lead Concentration μg/dl (95th percentile):	**NA**	

CR Cancer risk
HI Hazard index
NC Not calculated
RME Reasonable maximum exposure

is generally considered conservative for organic chemicals), the total cancer risk is unchanged. The estimated cancer risk based on CTE parameters is 5×10^{-7} (Table 12-5). However, this estimate does not account for potential underestimates in the dermal absorption and toxicity of PAHs. A summary of the risk estimates and qualitative factors modifying these estimates is presented in Table 12-6; uncertainties are discussed in Section 12.4.3.

12.4.2.6. The total hazard index for waste processor workers was estimated to equal 0.002. Using CTE parameters, the hazard index was estimated to equal 0.0007. The hazard index of 0.002 does not include the inhalation pathway because none of the COPCs had inhalation reference doses. However, all of the inhalation exposure doses are on the order of 10^{-9} mg/kg/day (see Appendix K), and toxic effects are not expected at these doses (see the discussion of uncertainties in Section 12.4.3.).

12.4.2.7. Potential Future Construction Worker. The excess lifetime cancer risk for potential future construction workers was estimated to equal 6×10^{-7} (Table 12-7). Most of this risk is from dermal and to a lesser extent, ingestion of carcinogenic PAHs. The total hazard index for potential future construction workers was estimated at 0.006. Factors that could lead to underestimates of the risks for construction workers are similar to those for the Waste Processor workers. However, it is unlikely that the cancer risk would exceed 1×10^{-6} or the hazard index would exceed 1. The factor that could potentially lead to the greatest underestimate of risk is the dermal absorption of PAHs. As in the case of the Waste Processor workers, the dermal absorption factor may be an underestimate for PAHs, but it is unlikely that the overall estimate of the dermal cancer risk is an underestimate. Consequently, no significant risks are expected to be associated with a construction worker at SWMU 37. One possible exception is if dermal carcinogenicity of PAHs is substantially greater than indicated by the absorbed dose.

12.4.2.8. Potential Future TEAD-N Resident. For SWMU 37, the cancer risk from all exposure pathways was estimated to equal 6×10^{-4}, and the hazard index was estimated to equal 60. As shown in Table 12-8, the excess lifetime cancer risk for potential future residents exposed to soil at SWMU 37 was estimated to equal 5×10^{-5}. Most of the calculated cancer risk is from ingestion and dermal exposure to carcinogenic PAHs and dioxins/furans. The total hazard index for potential future child residents exposed to soil was estimated to be 0.03. While the risk estimates are thought to be overestimates (including the dermal route, since the likelihood of having all exposed skin covered by soil is less for a resident in an area mostly covered by grass or pavement than it is for a construction worker), it would not be surprising if the cancer risk exceeded 1×10^{-6} if the pathway was completed. However, because

TABLE 12-5

SWMU 37 - CONTAMINATED WASTE PROCESSING PLANT
CTE CANCER RISK AND HAZARD INDEX
FOR WASTE PROCESSOR WORKERS

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	9.8E-01	NC	NC	8E-12	8E-12	<1
Dioxins/Furans	2.3E-05	5E-08	3E-08	4E-12	8E-08	18
Carcinogenic PAHs	1.8E+00	2E-07	2E-07	NC	4E-07	82
2,4,6-Trinitrotoluene	5.0E-01	2E-10	1E-10	NC	4E-10	<1
Pathway Total		3E-07	2E-07	1E-11		
Percent of Total		55	45	<1		
				Total Cancer Risk	**5E-07**	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Cadmium	9.8E-01	2E-04	5E-05	NC	3E-04	38
Selenium	3.7E-01	2E-05	3E-07	NC	2E-05	2
2,4,6-Trinitrotoluene	5.0E-01	2E-04	1E-04	NC	3E-04	50
Benzo[g,h,i]perylene	1.1E+00	8E-06	7E-06	NC	2E-05	2
Fluoranthene	1.7E+00	9E-06	8E-06	NC	2E-05	3
Pyrene	1.6E+00	1E-05	1E-05	NC	2E-05	3
Phenanthrene	9.5E-01	7E-06	6E-06	NC	1E-05	2
Pathway Total		5E-04	2E-04	NC		
Percent of Total		70	30	NC		
				Total Hazard Index:	**7E-04**	
				Blood Lead Concentration µg/dl (50th percentile):	**NA**	

CR Cancer risk
HI Hazard index
NC Not calculated
CTE Central tendency exposure

TABLE 12-6

TEAD-N BASELINE RISK ASSESSMENT
SWMU 37–CONTAMINATED WASTE PROCESSING PLANT PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (µg/dl)	Key Chemicals (a)
Waste Processor Worker					NC	
Ingestion	Current likely	Medium/High	0.001	3×10^{-6}		Cadmium, dioxins/furans, carcinogenic PAHs, 2,4,6-trinitrotoluene
Dermal	Current likely	High/Neutral-High	0.001	7×10^{-6}		
Inhalation	Current likely	High/High	NC	2×10^{-8}		
Construction Worker					NC	
Ingestion	Future likely	Medium/High	0.005	4×10^{-7}		Cadmium, dioxins/furans, carcinogenic PAHs, 2,4,6-trinitrotoluene
Dermal	Future likely	High/Neutral-High	0.001	2×10^{-7}		
Inhalation	Future likely	Medium/High	NC	1×10^{-8}		
TEAD-N Resident					NC	
Ingestion	Future unlikely	Medium/High	0.02	3×10^{-5}		Carcinogenic PAHs, 2,4,6-trinitrotoluene
Dermal	Future unlikely	High/High	0.005	2×10^{-5}		
Inhalation	Future unlikely	High/High	NC	4×10^{-8}		
Vegetable Crops	Future unlikely	High/High	60	6×10^{-4}		
Beef	Future unlikely	High/Neutral	0.000001	2×10^{-7}		

NC Not calculated; lead is present at background levels
PAHs Polyaromatic hydrocarbons
TEAD-N Tooele Army Depot North Area

(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

TABLE 12-7

SWMU 37 - CONTAMINATED WASTE PROCESSING PLANT
RME CANCER RISK AND HAZARD INDEX FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	9.8E-01	NC	NC	9E-09	9E-09	2
Dioxins/Furans	1.6E-05	8E-08	3E-08	3E-09	1E-07	20
Carcinogenic PAHs	1.2E+00	3E-07	2E-07	NC	4E-07	79
2,4,6-Trinitrotoluene	5.0E-01	5E-10	2E-10	NC	7E-10	<1
		4E-07	2E-07	1E-08		
		66	32	2		
				Total Cancer Risk	6E-07	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Cadmium	9.8E-01	2E-03	3E-04	NC	3E-03	43
Selenium	3.7E-01	2E-04	2E-06	NC	2E-04	3
2,4,6-Trinitrotoluene	5.0E-01	2E-03	8E-04	NC	3E-03	53
Benzo[g,h,i]perylene	9.8E-01	8E-06	4E-06	NC	1E-05	<1
Fluoranthene	1.2E+00	7E-06	4E-06	NC	1E-05	<1
Pyrene	1.1E+00	9E-06	5E-06	NC	1E-05	<1
Phenanthrene	6.5E-01	5E-06	3E-06	NC	8E-06	<1
		5E-03	1E-03	NC		
		81	19	NC		
				Total Hazard Index:	6E-03	

CR Cancer risk
HI Hazard index
NC Not calculated
RME Reasonable maximum exposure

TABLE 12-8

SWMU 37 - CONTAMINATED WASTE PROCESSING PLANT
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Cadmium	6.9E-01	NC	NC	2E-08	NC	NC	2E-08	<1
Dioxins/Furans	2.3E-05	6E-06	3E-06	2E-08	4E-05	9E-08	5E-05	8
Carcinogenic PAHs	1.8E+00	2E-05	2E-05	NC	4E-04	7E-08	4E-04	66
2,4,6-Trinitrotoluene	5.0E-01	2E-08	1E-08	NC	2E-04	1E-13	2E-04	26
Pathway Total		3E-05	2E-05	4E-08	6E-04	2E-07		
Percent of Total		4	3	<1	92	<1		
					Total Cancer Risk:		**6E-04**	

Hazard Index (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Cadmium	6.9E-01	9E-03	8E-04	NC	2E-01	3E-07	2E-01	<1
Selenium	3.0E-01	8E-04	5E-06	NC	NC	NC	8E-04	<1
2,4,6-Trinitrotoluene	5.0E-01	1E-02	3E-03	NC	6E+01	4E-08	6E+01	99
Benzo(g,h,i)perylene	3.4E-01	1E-04	6E-05	NC	1E-03	5E-07	2E-03	<1
Fluoranthene	1.7E+00	5E-04	2E-04	NC	3E-02	1E-07	3E-02	<1
Pyrene	1.6E+00	7E-04	3E-04	NC	4E-02	2E-07	4E-02	<1
Phenanthrene	9.2E-01	4E-04	2E-04	NC	3E-02	5E-08	3E-02	<1
Pathway Total		2E-02	5E-03	NC	6E+01	1E-06		
Percent of Total		<1	<1	NC	100	<1		
					Total Hazard Index:		**6E+01**	

CR	Cancer risk
HI	Hazard index
NA	Not applicable
NC	Not calculated
RME	Reasonable maximum exposure
TEAD-N	Tooele Army Depot North Area

residents are unlikely to live at what is now SWMU 37, the significance of the risk estimates is diminished.

12.4.2.9. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 37, the estimated cancer risk is 6 x 10^{-4} and the hazard index is 60 (Table 12-8), primarily due to carcinogenic PAHs and 2,4,6-TNT. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has several orders of magnitude of uncertainty because of uncertainties in the plant uptake factors (see Section 12.4.3.). If plants metabolize 2,4,6-TNT (which is not accounted for in the uptake model), the risk from explosives via this pathway would be low. Because of the high degree of uncertainty, the significance of these risk estimates is unknown.

12.4.2.10. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 37, the estimated cancer risk is 2 x 10^{-7} and the hazard index is 0.000001 (Table 12-8). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 37 if they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

12.4.3. Uncertainties

12.4.3.1. The exposure estimates and toxicity values have associated uncertainties, the magnitude and nature of which affect the degree of confidence in the results. Most of the uncertainties are such that risk estimates could be lower, but are unlikely to be higher than estimated. The following paragraphs discuss uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor. These discussions focus on elements contributing the most to overestimates of the total risk, and on areas where risks may be underestimated. Uncertainties in the toxicity values were

discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most to risk.

12.4.3.2. Sampling at SWMU 37 included judgmental sample collection from areas where stained soil was observed, and areas likely to have received spills and runoff. Consequently, the exposure point concentrations are upper bound estimates from a data set that included sampling locations likely to have the highest COPC concentrations. Therefore, the exposure point concentrations should be higher than the average concentrations of the contaminants.

12.4.3.3. Surface soil samples collected at SWMU 37 were composited from five aliquots evenly distributed on a 5-foot radius. Compositing samples adds uncertainty to the results because the data may not show local hot spots, or may under-represent a hot spot if a highly contaminated sample is blended with samples which are relatively clean. However, a potential hot spot within the 5-foot radius that was sampled would not significantly affect potential risks at the site, because potential receptors would not be exposed only to soil from an area that small for an extended period of time.

12.4.3.4. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

12.4.3.5. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical with a reference dose below 1×10^{-6} mg/kg/day, and this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic

effects via inhalation of metals with exposure doses greater than 1 x 10^{-6} was examined on a case-by-case basis. The results of this evaluation were presented in Section 12.4.2. Exposure doses are summarized in Appendix K.

12.4.3.6. Waste Processor Worker. One factor affecting the cancer risk estimates for the waste processor worker is the assumption that exposure will take place over a 25-year period. Most people change jobs, or their job location, more frequently. The resulting cancer risk would be reduced according to how long a person is actually at the contaminated job location.

12.4.3.7. As has been noted, dermal exposure is the route with the greatest exposure to PAHs. Dermal absorption of PAHs has been studied, but deficiencies in the experimental design indicate that absorption could be an order of magnitude greater than was assumed (USEPA, 1992). It should also be noted that PAHs may cause skin tumors, and the use of a dermal slope factor based on the absorption of PAHs into the bloodstream may underestimate toxicity. A factor which has probably been overestimated is the area of exposed skin covered with soil and dust. While the skin area itself is probably a reasonable estimate, not all exposed skin will be covered with soil on a daily basis. This will reduce the exposure from what was estimated.

12.4.3.8. The primary uncertainties that could lead to an underestimate of the inhalation risk are the absence of slope factors and reference doses for several COPCs. Assuming that the inhalation slope factor is the same as the oral slope factor for PAHs and 2,4,6-TNT would leave the risk estimate of 5 x 10^{-7} unchanged. Also, the daily inhalation exposure doses are on the order of 10^{-8} mg/kg/day or less (see Appendix K), and it is not expected that compounds would cause adverse effects at these levels. Other factors also tend to overestimate potential risk. The assumed dust level of 50 $\mu g/m^3$, which is the National Ambient Air Quality Standard for respirable dust, is probably an overestimate since SWMU 37 is small, and only a small fraction of the dust will originate within the SWMU. Uncertainties related to ingestion exposure primarily derive from the soil ingestion rate. A typical ingestion rate for adults is probably closer to 25 mg/day (DTSC, 1992), rather than the 50 mg/day assumed in this risk assessment.

12.4.3.9. Construction Worker. Because all of the risk estimates are below levels considered significant, only uncertainties in those parameters which may lead to underestimates require discussion. These parameters are the dermal absorption factors, the absence of inhalation slope factors, and the absence of inhalation reference doses.

Reasons why these parameters are unlikely to have a major affect on the overall risk estimates were discussed under Risk Characterization (Section 12.4.2.).

12.4.3.10. TEAD-N Residents. The uncertainties for Waste Processor workers also apply to the evaluation of future residents within TEAD-N, although the magnitude of the uncertainties differs. In a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure and (to a lesser extent) reduces the potential for dermal and ingestion exposure. As in the case of the Waste Processor workers, uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the dust level. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who directly eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate exceeds the assumed rate of 200 mg/day. For dermal exposure, young children may cover more of their skin with soil than adults, and the assumed surface area of skin covered with soil is probably more reasonable for this age group than for adult workers.

12.4.3.11. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that the plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

12.4.3.12. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53.

12.4.3.13. There is even greater uncertainty at SWMU 37. The estimated risks for the produce exposure pathway are dominated by carcinogenic PAHs and 2,4,6-TNT. However, the equation used to estimate the plant uptake factors from the log K_{ow} was developed using mostly data for pesticides, which are different from PAHs and explosives; a poorer fit would be expected for PAHs and explosives than for compounds

used to develop the relationship. The plant uptake model also does not account for metabolism of the chemical by the plant. Based on its polar structure, it would not be surprising if plants metabolize 2,4,6-TNT, thus eliminating exposure to explosives by humans through this pathway. In addition, because the salt content of the soil is currently toxic to plants (see Section 12.4.1.4.), the soil would need to be diluted with peat or other soil amendments to grow produce. This has not been accounted for in the exposure calculations. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

12.4.4. Recommendations

12.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Allow unrestricted use of this site as long as it remains part of the depot

- Evaluate the need for institutional controls and/or corrective action in a Corrective Measures Study should this land no longer be controlled by the depot.

12.5 ECOLOGICAL RISK ASSESSMENT

12.5.0.1. This section discusses the results of the Tier 1 and Tier 2 ecological evaluations at SWMU 370. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4.

12.5.1. Tier 1

12.5.1.1. Ecological Receptors. The area within SWMU 37 has been disturbed by site activities and supports a variety of weedy species including gumweed, Russian thistle, cheatgrass, yellow sweetclover, and annual sunflower. Yellow sweetclover is an introduced reclamation species that has spread throughout the area. One Russian olive tree, an introduced species, was also growing within the SWMU fence line. The berms supported rubber rabbitbrush, gumweed, cheatgrass and annual sunflower. Crested wheatgrass, another introduced reclamation species, was also common. Native species observed outside the SWMU fence line were Indian ricegrass, sand dropseed, red three-

awn, needle-and thread grass, Douglas rabbitbrush and matchweed. The perimeter of SWMU 37 is dominated by big sagebrush with a grassy understory and scattered shrubs of rubber rabbitbrush and matchweed. The mapped range and soil type are:

Range Site: Semi-Desert Gravelly Loam
Soil Types: Hiko Peak gravelly loam with 2-15 percent slopes

12.5.1.2. Expected Climax Vegetation. The range site describes the climax vegetation expected to occur at each site due to the combined influence of environmental factors characteristic of the site. In this range site, Wyoming Big Sagebrush is the dominant and conspicuous plant species. Other dominant species expected in the semi-desert gravelly loam range site near this SWMU are bluebunch wheatgrass, Indian ricegrass, Douglas rabbitbrush, bottlebrush squirreltail, and Hood phlox (USSCS, 1991).

12.5.1.3. Wildlife. No reptiles were observed at SWMU 37 but, based on sightings elsewhere at the Depot, the collared and side-blotched lizard, the western whiptail, the Great Basin rattlesnake and the gopher snake may be inhabitants at or near SWMU 37.

12.5.1.4. Indicators of small mammal activities such as tracks, active burrows, stem cuttings, and diggings for seed burial were observed at the SWMU. Rabbit pellets from black-tailed jackrabbits and cottontail rabbits were also observed. Based on observations elsewhere at the Depot and the type of habitat, other common small mammal species that are probable inhabitants of SWMU 37 include the Ord's kangaroo rat, deer mouse, Great Basin pocket mouse, pinyon mouse, sagebrush vole, desert woodrat (although no wood rat nests were observed), and the little pocket mouse (Burt and Grossenheider, 1980; RUST, 1994). No large mammals were observed at SWMU 37. Deer pellets and coyote scat were observed, and antelope may occasionally frequent the area.

12.5.1.5. An American kestrel and a red-tailed hawk were observed at this SWMU. Other raptors such as the golden eagle, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, and the great-horned owl have been observed in other areas of TEAD-N. Because of the typical range of these species during foraging/hunting activities, they may be present at SWMU 37 on an intermittent basis.

12.5.1.6. A meadow lark was observed. The sage grouse, a State of Utah sensitive species, may inhabit the undisturbed areas of the SWMU. Many other non-game birds such as crows and several families of passerine birds would be expected.

12.5.1.7. Results of the Tier 1 Ecological Assessment. The field surveys indicate that the vegetation at SWMU 37 has been impacted to a greater degree by the physical activities at the site than by the chemicals that have been released. The ecological assessment, therefore, addresses the potential adverse impacts to the wildlife receptors, and it is not deemed necessary to address the ecological effects on the vegetation. The ecological assessment is performed with the assumption that the wildlife receptors are not limited by the physical boundaries of each SWMU; therefore, the spatial distribution of the detected chemicals at SWMU 37 is assumed to potentially expose the wildlife species that occur, or that may potentially occur, at the TEAD-N facility as a whole. The results of the Tier 1 assessment indicate that the detected levels of some of the chemicals at SWMU 37 warrant a Tier 2 evaluation.

12.5.2. Tier 2

12.5.2.1. The objective of the Tier 2 assessment is to further evaluate the Tier 1 COPECs by comparing the receptor's chemical exposure dose to a biological endpoint.

12.5.2.2. Exposure Analysis. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil. Indirect exposure occurs via the food web, such as when a raptor consumes the mouse. SWMU 37 has no surface water, so the surface water exposure pathway is incomplete and is excluded from the ecological assessment.

12.5.2.3. The reptiles potentially inhabiting SWMU 37 may be exposed via direct pathways (ingestion and dermal exposure to soil) and, to a lesser extent, via food web pathways (e.g. ingestion of contaminated insects). As prey, they may also expose predators.

12.5.2.4. Small mammals are predominantly exposed via direct pathways (ingestion of soil) and, to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators. The antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing) and, as prey, may expose predators. The coyote (a predator) is exposed predominantly via food web pathways.

12.5.2.5. The predominant route of exposure for the raptors is via food web pathways because they typically do not spend much time on the ground. The non-raptor birds are exposed via food web pathways by ingestion of seeds and grasses, and by direct exposure to soil during preening.

12.5.2.6. Risk Characterization. The ecological risk characterization for the COPECs at SWMU 37 is based on the ecological toxicity quotient derived by comparing either the dose ingested by the indicator species or the chemical concentration in the soil to a biological endpoint. The ingestion pathway is associated with the greatest exposure at TEAD-N. The results of the ecological evaluation are in Appendix K. The results indicate that the COPECs at SWMU 37 have ETQs less than 1.0; therefore, there is no potential adverse impact to ecological receptors at this site.

12.5.3. Recommendations

12.5.3.1. Based on the preceding discussions, SWMU 37 is recommended for no further investigation regarding potential ecological effects.

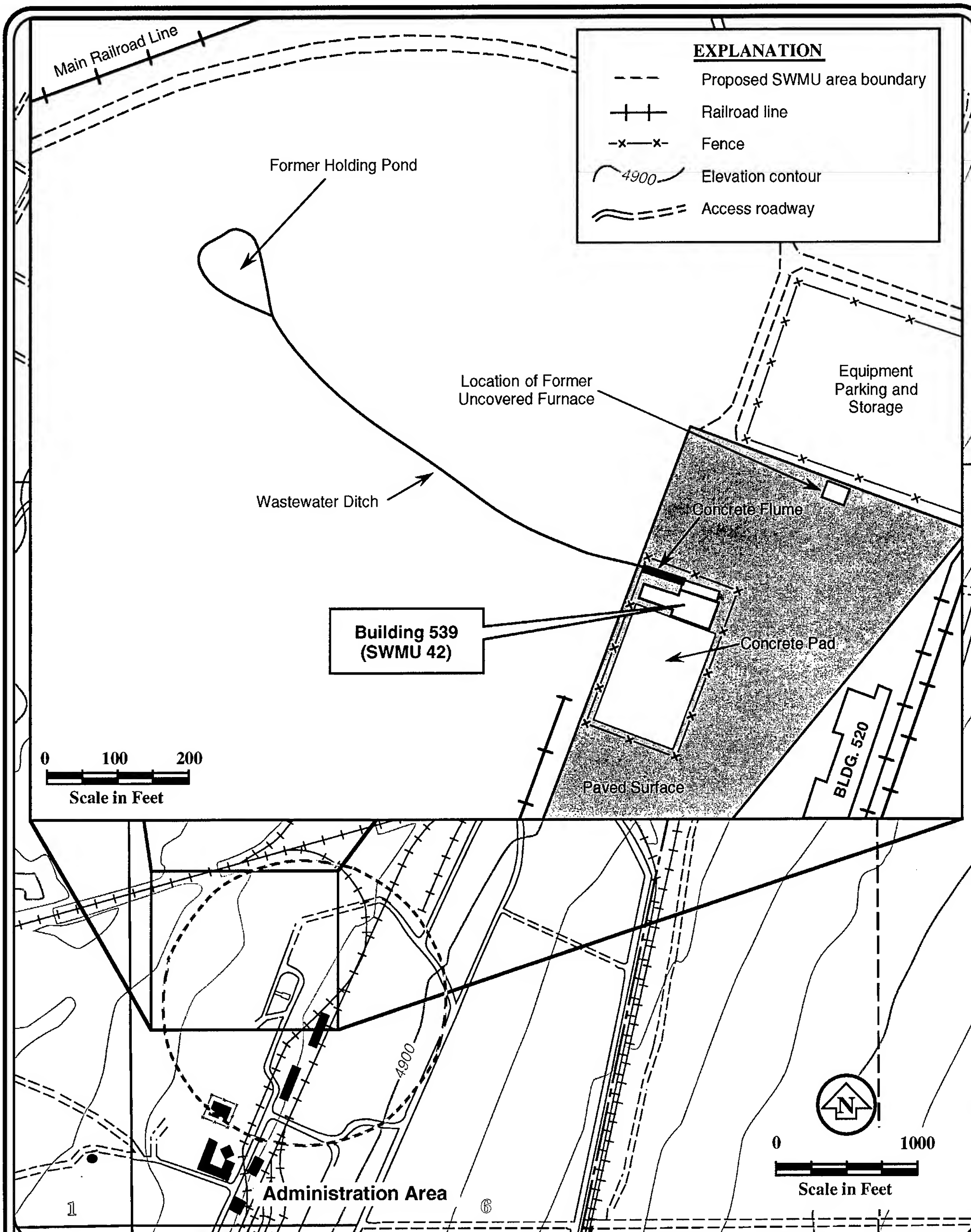
13.0 BOMB WASHOUT BUILDING (SWMU 42)

13.1 SITE BACKGROUND

13.1.0.1. Site Description. The Bomb Washout Building (Building 539) is located in the southeastern portion of TEAD-N, north of the Administration Area, as shown in Figure 13-1. The site history and description were compiled from communications with present and former TEAD-N personnel (Mascarenas, 1990; Clark, 1990; Crist and McIntyre, 1993). Building 539 is a wood frame building with a tin roof and concrete floor which previously contained a demilitarization furnace for small arms munitions. Building 539 has recently been renovated and now serves as a vehicle washing and staging facility for the U.S. Marine Corps. A concrete parking area has been added to the south of the building, and a chain-link security fence has also been placed around the perimeter. The building itself has been re-roofed and re-sided with aluminum. Much of the surrounding area is paved, although the pavement is weathered and broken in several places. According to TEAD-N personnel, it was probably paved sometime in the 1940s or 1950s (Mascarenas, 1990).

13.1.0.2. Building 539 was never connected to the IWL or IWTP. According to TEAD-N personnel, there are no floor drains in the building (Mascarenas, 1990). During operation, wastes from the incineration and lead reclamation process may have included splatter and spillage of molten lead onto the floor. When the building was cleaned, wash water was discharged via a steel lined concrete flume which extends from the northeast corner of the building. The flume, which is still present, runs east-west about 10 feet north of the building and discharges into an open ditch west of the building. The ditch extends approximately 600 feet to an unlined holding pond located in an open area west of Building 539 and south of the main line railroad tracks. The holding pond, which is currently overgrown with weeds and sagebrush, was reportedly 50 feet in diameter and 1 to 2 feet deep.

13.1.0.3. Operational Activities. Between the early 1940s and the early 1960s, projectiles from small arms (.30 and .50 caliber) were burned in a retort furnace located in this building. Molten lead was reclaimed during the process in troughs located in the building beneath the furnace. The lead was then placed into molds to make ingots (measuring approximately 3 inches by 3 inches by 12 inches) that were later sold to private firms. During operation, the furnace generated a significant amount of visible



Source: *Modified from USGS Tooele 7.5 minute quadrangle.*

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs

BOMB WASHOUT BUILDING—SWMU 42 LOCATION MAP

FIGURE 13-1

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smoke (Mascarenas, 1990). Because no air emission control devices (such as a baghouse or cyclone) were installed on the smokestack, heavy particulates from the smokestack flue would settle out into a steel 4-foot by 4-foot by 6-foot deep "drop-out box" located on the roof of the building. Potential airborne contaminants may have been released to the air and surrounding soils by smokestack emissions. The furnace was dismantled sometime around 1960, and the building was used for storage until recently. The building has been renovated for use as a vehicle storage area, and water and electrical services have been added.

13.1.0.4. Reportedly, another furnace was located approximately 225 feet north of Building 539 (Mascarenas, 1990). This furnace, which was apparently not enclosed inside a building or covered, was used to incinerate fuses and other small munitions and is no longer present. During a site visit by Montgomery Watson personnel, footings and metallic lead residue were observed on the ground at the reported location (JMM, 1991). This furnace was reportedly about the same size as the one in Building 539, and was operated during the same time period (early 1940s to early 1960s) (Mascarenas, 1990; Crist and McIntyre, 1993).

13.1.0.5. A more recent site visit by Montgomery personnel to SWMU 42 revealed that two other deactivation furnaces were in operation in Building 520 from the early 1950s up to about 1967 (Crist and McIntyre, 1993). These furnaces were located in the basement of the northern part of Building 520, and were used for popping primers and melting lead for recycling. Propellant was collected in a vacuum collection system for sale to munitions manufacturers. The clean brass resulting from the process was transported over a cooling tower and loaded onto rail cars for recycling. Both furnaces burned propane to externally heat the furnace and not oxidize the lead and brass. For this reason, neither furnace produced ash residue. In addition, no wash water was generated at either furnace in Building 520 (Crist and McIntyre, 1993). During operation, the furnace emissions were exhausted through 25- to 30-foot high smokestacks (Crist and McIntyre, 1993). Also during this site visit, it was discovered that Building 520 employees disposed of waste solvents just off the asphalt along the west side of Building 520. The quantity of solvents disposed of here is unknown but thought to have been only a small amount.

13.1.0.6. Geology and Hydrology. Soils beneath the Building 539 area include silty sands and gravelly sands (Jordan, 1989), which grade to gravelly and very gravelly loams at a depth of 1 to 3 feet bgs. These soils are mapped as Abela Series. Little groundwater

elevation data in the immediate vicinity of Building 539 exists; based on water levels measured by Montgomery Watson during the Phase I RFI (1992-1993), depth to groundwater in this area is expected to be approximately 400 feet, and the direction of groundwater flow is toward the northwest (Jordan, 1990). Bedrock is approximately 1,500 feet bgs in this area (ERTEC, 1982).

13.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

13.2.1. Previous Investigations

13.2.1.1. On March 2, 1990, EMO personnel collected seven soil/waste samples from Building 539 and the associated ditch and former holding pond area. Descriptions of the sample locations are as follows:

- A A sample of granulated metal debris from the drop-out box located outside Building 539
- B Background surface soil sample from an area higher in elevation than the ditch or former pond
- C Surface soil sample from the downgradient end of the culvert
- D Surface soil sample 25 feet downgradient from the culvert
- E Surface soil sample 85 feet downgradient from the culvert
- F Surface soil sample from the southeast corner of the former holding pond (no water was present)
- G Surface soil sample from the center of the pond (no water was present).

All of the samples were analyzed for total metals, EP Toxicity metals, total organic halogens, VOCs, and RCRA characteristics for reactivity, pH, and ignitability.

13.2.1.2. According to the TEAD-N EMO, none of the samples contained detectable levels of total organic halogens or VOCs. Several metals, including barium, cadmium, chromium, lead, mercury, nickel, and silver, were detected at concentrations that

exceeded those in the background soil sample (sample "B") by one order of magnitude or more. The sample of granulated metal in the drop-out bin (sample "A") contained elevated total metal concentrations of barium (6,493.88 mg/kg), cadmium (31.78 mg/kg), chromium (171.77 mg/kg), lead (68,117.65 mg/kg), mercury (3.65 mg/kg), nickel (138.21 mg/kg), and silver (1.68 mg/kg). All soil samples from the ditch and pond area (C, D, E, F, and G) contained several metals at levels exceeding those in the background soil sample. Concentrations generally decreased as distance from the culvert increased. Four of the samples (C, D, E, and G) exceeded the maximum EP Toxicity concentration limits for barium (100 mg/l) and three of the samples (C, D, and E) exceeded EP Toxicity limits for lead (5.0 mg/l).

13.2.1.3. In May, 1993 AEHA conducted a Removal Action Assessment at SWMU 42 to assist in determining the extent of contamination from previous demilitarization activities (AEHA, 1993). A Health Risk Assessment (HRA) was also completed based on the results of the study. This assessment was conducted because the levels of contamination found during the Montgomery Phase I RFI could pose an imminent health risk to the Marines currently occupying Building 539 and surrounding areas. Surface soil samples were collected on a grid pattern along three sides of the former Bomb Washout facility, and 27 samples submitted for metals analyses (for barium, beryllium, cadmium, lead, and thallium) and for the explosives 2,4-DNT and 2,6-DNT. Three soil samples were submitted for background metals analyses, and 13 samples were submitted for TCLP metals analyses.

13.2.1.4. The conclusions from the AEHA assessment were as follows:

- Personnel working within the Marine vehicle maintenance facility are not at risk from contaminated soil.

- Based on data from the TCLP analyses, soils contaminated with greater than 1,000 mg/kg of total lead would require management as hazardous waste if removed as part of a future remedial action.

- Personnel should be prohibited from the areas north and west of Building 539 and the vehicle storage yard, where the lead concentration locally exceeds 1,000 mg/kg in soil, until future remediation of the site is accomplished.

13.2.2. RFI Sampling Summary

13.2.2.1. Phase I Sampling. An extensive surface and shallow soil sampling program was conducted in the vicinity of the Bomb Washout Building during the initial investigation. During this program, thirteen 5-foot deep soil borings were drilled and sampled at two intervals each, and six surface soil samples were collected. Soil samples collected from the 5-foot borings were taken from the ground surface and from the total depth (5 feet). The shallow soils encountered were classified as silty sands and sandy silts. However, several of the borings in the western portion of the SWMU encountered a silty gravel at about 3–5 feet bgs. All samples were analyzed for metals and explosive compounds.

13.2.2.2. Phase II Sampling. The following sampling activities were conducted at SWMU 42 during the Phase II investigation (see Section 3.2 for a description of these activities):

- Field X-ray fluorescence (XRF) screening for lead and strontium was conducted on 135 soil samples to aid in the delineation of metals contamination of the surface soils and to assist in siting shallow soil borings.

- Eight surface soil samples were collected for metals analysis to serve as laboratory confirmation for the XRF field screened soils.

- One surface soil sample was collected from a location distant from SWMU 42, but in the same soil type, to provide background information on metals concentrations in the soils. Additional surface soil sampling was conducted to address data gaps identified during regulatory review of this document. Six surface soil samples were collected for hexavalent and total chromium to provide data to estimate the concentration of chromium that is present in the more toxic hexavalent state. Three surface soil samples were collected for dioxin/furan analysis to investigate the areal distribution of these isomers.

- Three 3-foot soil borings were drilled at locations judged to be distant from the former activities at SWMU 42, and two soil samples were submitted from each for metals analysis (six samples total) to provide SWMU-specific data on background metals concentrations.

- Two 5-foot borings were placed along the edge of asphalt west of the northern portion of Building 520, and two samples from each submitted for VOCs and SVOCs analyses.
- Twenty 5-foot borings were drilled to investigate horizontal and vertical contamination from previous furnace activities, and two samples from each boring were submitted for metals and explosives analyses (40 samples total).
- Twelve 10-foot borings were located on either side of the discharge ditch and holding pond west of Building 539 to further characterize the horizontal subsurface migration of contaminants from these source areas; four samples were submitted from each boring for metals analysis (48 samples total).
- Four 100-foot borings were drilled in the discharge ditch and holding pond to investigate the depth of contaminant migration due to infiltration from these sources, and five soil samples were collected from each boring for metals and explosives analyses (20 samples total).
- A geophysical survey was conducted over an approximately 38-acre field west and north of Building 539 to investigate the possibility of buried debris being present.
- Based on the results of the geophysical survey, seven test pits were excavated and logged in this field, and two of them were sampled for metals and explosives (four samples total).
- Two shallow (2-3 feet) hand borings were augered, and two samples collected from each boring to investigate the soils underneath areas of ash and metal debris present on the surface.
- Four air monitoring stations were established and TSP sampling was conducted over a two month period. The collected samples from each station were composited monthly, resulting in a total of eight samples.
- An ecological survey was conducted to help evaluate the risks to the environment posed by the contaminants present.

13.2.2.3. Data Completeness Evaluation. The result of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that most of the SWMU 42 data are usable, some with qualification. The USAEC chemistry branch added qualifiers to one sample for explosives due to holding

time nonconformance; Montgomery Watson chemists concurred with this qualification and rejected the data. The USAEC chemistry branch also qualified the results for one explosive, 2-nitrotoluene, in 17 soil samples since it had a low, low-spike recovery; all the results were below the CRL. Additionally, 19 other soil samples were qualified as estimated for inorganic and organic parameters by Montgomery Watson chemists due to MS/MSD nonconformances and blank contamination. The hexavalent chromium results for this SWMU are positively biased due to analytical method interferences and should be considered conservative. The completeness achieved was 100 percent for all parameters except explosives. The completeness for explosive is 98 percent. The overall completeness for explosives is acceptable for the needs of the project. Further details concerning the data review are presented in Appendix E of this document.

13.2.2.4. The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviations and the data quality objectives were met. Due to this, no data gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

13.3 CONTAMINATION ASSESSMENT

13.3.1. RFI Sampling Results

13.3.1.1. Surface Soils. Based on the results of the previous sampling conducted by TEAD, AEHA, and the RFI sampling program, it is apparent that both metals and explosives have been released to the soils in the vicinity of SWMU 42. As shown in Figure 13-2, elevated metals in surface soils range up to 100,000 mg/kg (10 percent) for lead and 24,000 mg/kg (2.4 percent) for barium. The highest concentration of cadmium detected was 89.4 mg/kg while chromium ranged up to 852 mg/kg. The highest concentration of hexavalent chromium was 170 mg/kg, but the total chromium concentration in this sample (SS-42-017) was only 48.9 mg/kg. The laboratory reported that matrix interferences made the hexavalent chromium concentration difficult to determine, but all QA/QC criteria were met for total chromium in this sample. The concentration of chromium present in the hexavalent state was conservatively assumed to equal 100 percent of the total chromium concentration of 48.9 mg/kg in this sample. Elevated concentrations of most of the metallic analytes were detected in the surface soils. The highest surface metals concentrations are from locations associated with the previous wastewater flume, ditch, holding pond, and several furnace ash waste piles, but elevated metals are present in other areas as well.

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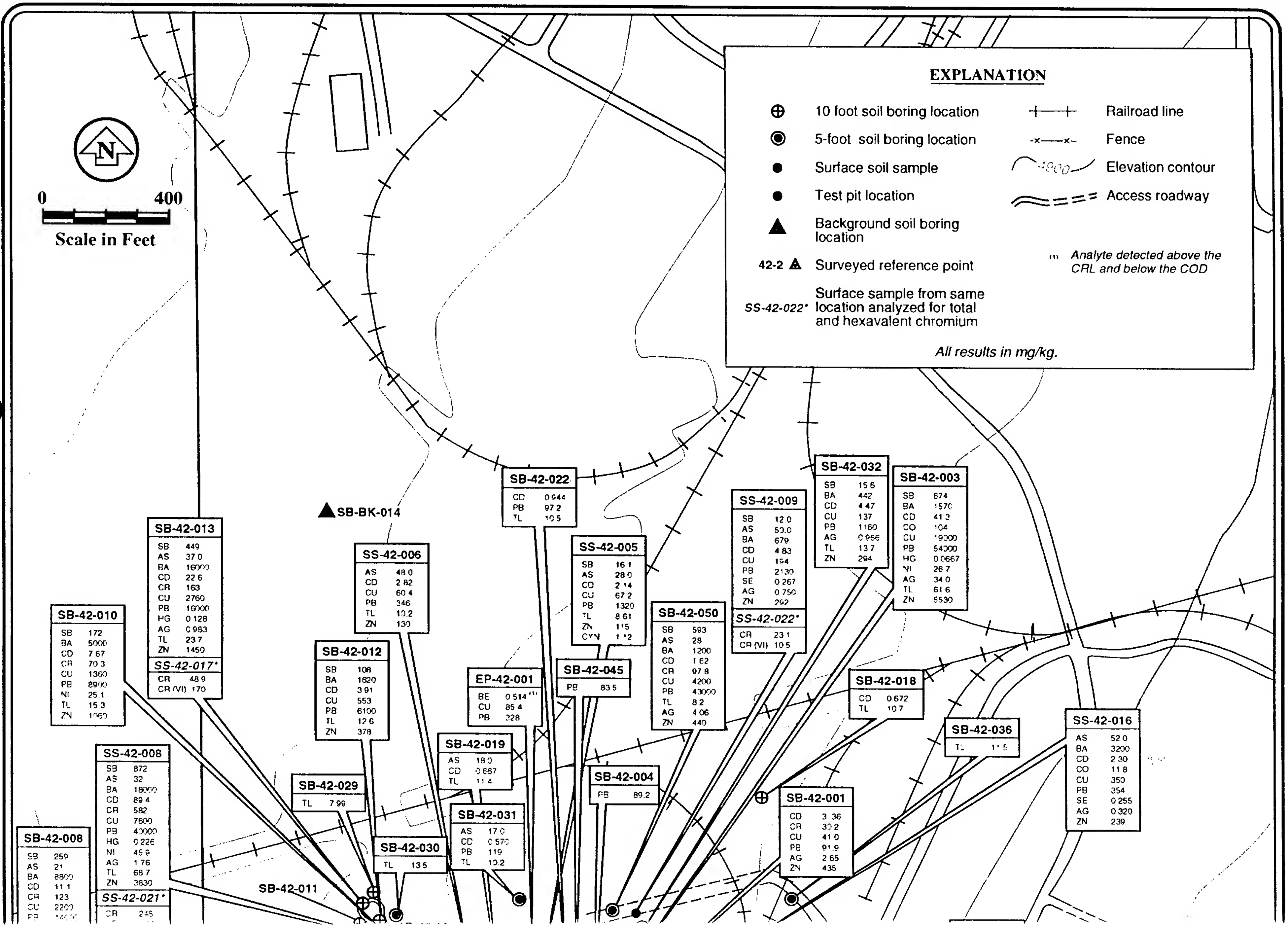

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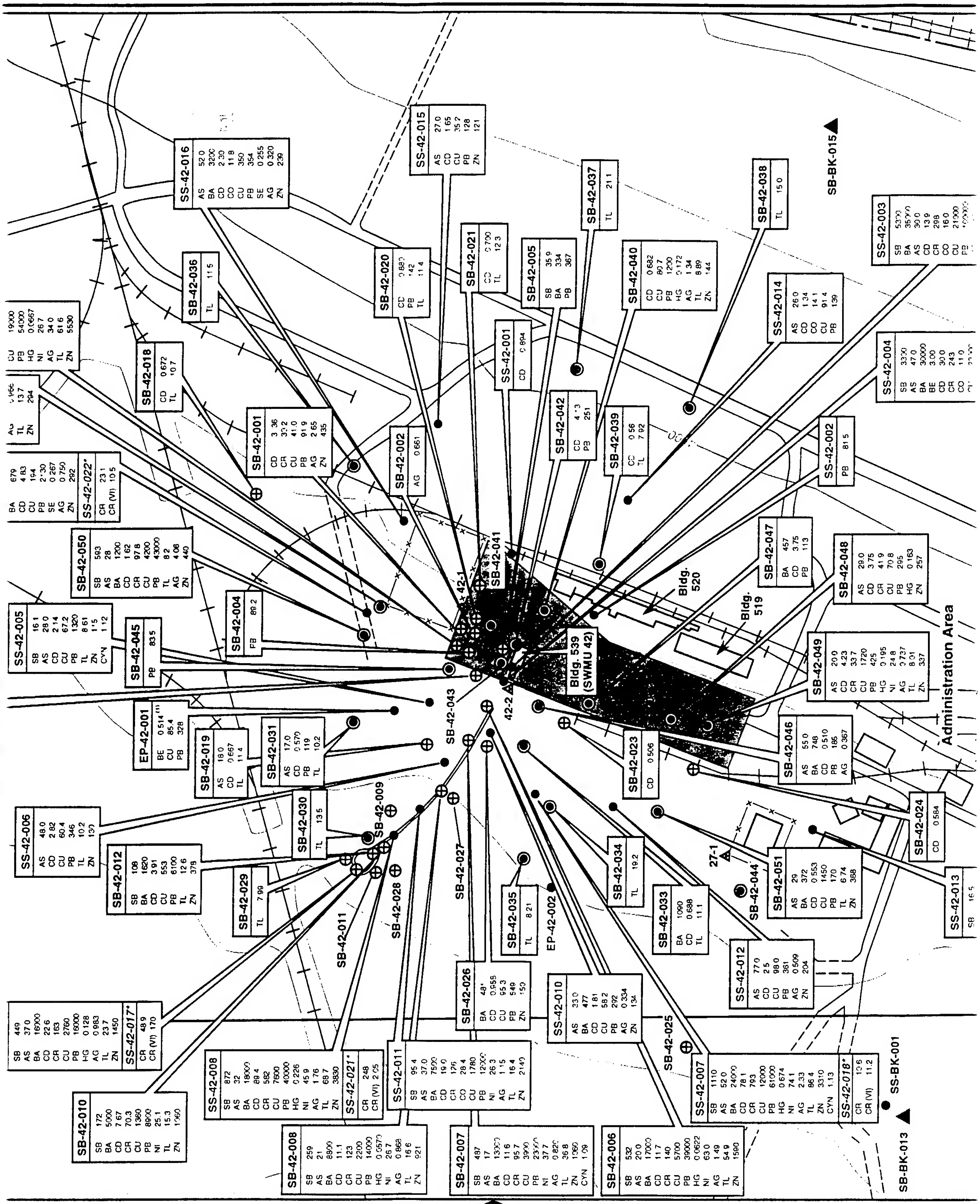

SS-42-016
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SB-BK-015
SS-42-003
SS-42-014
SS-42-004
SB-42-018
SS-42-001
SB-42-001
SB-42-002
SB-42-042
SB-42-039
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SB-42-045
Bldg. 520
Bldg. 519
Bldg. 539 (SWMU 42)
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Administration Area
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SB-42-019
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SB-42-046
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SB-42-011
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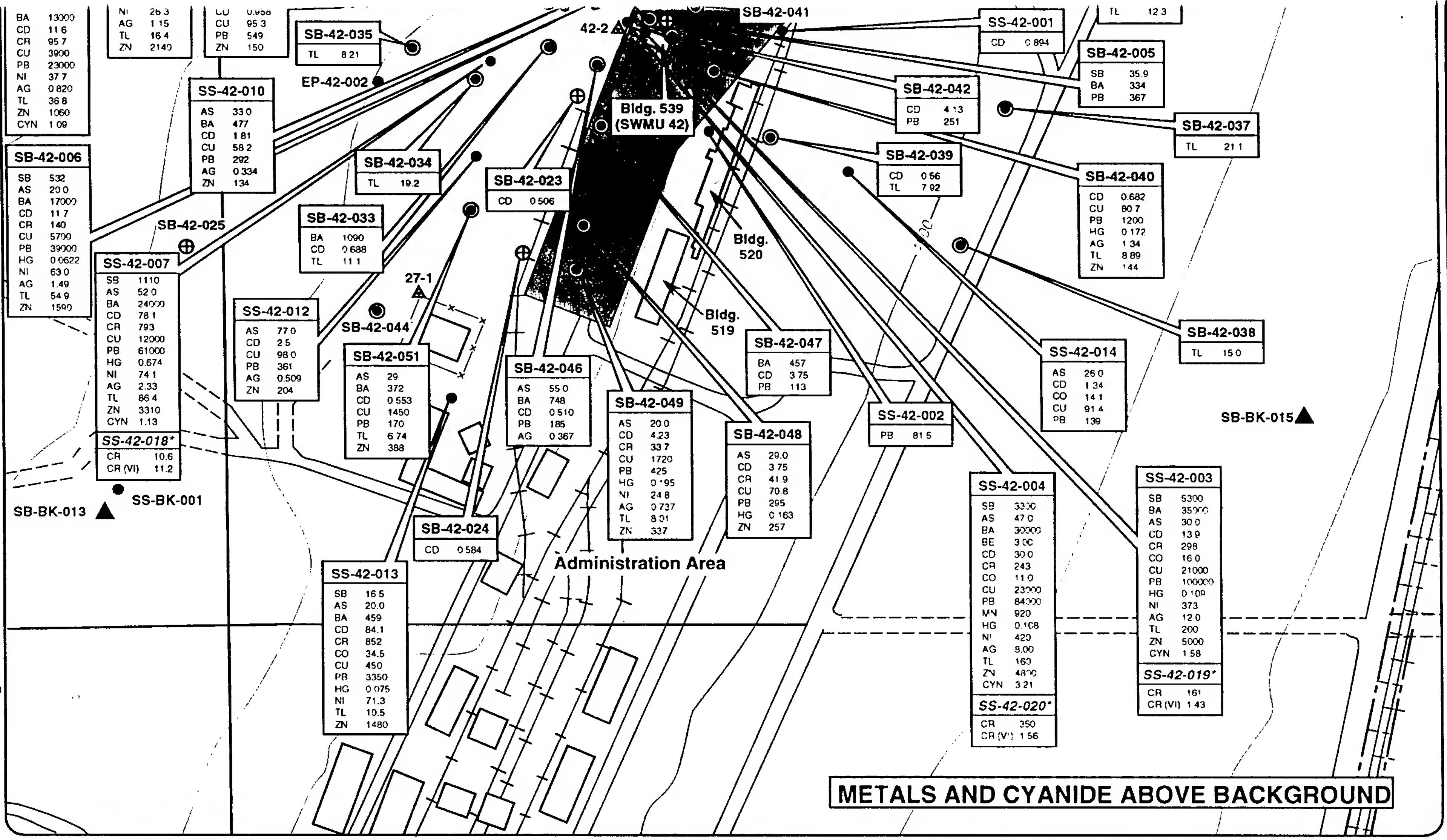


Source: Modified from USGS Grantsville and South Mountain 7.5 minute quadrangles.

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs

BOMB WASHOUT BUILDING—SWMU 42

ANALYTICAL RESULTS FOR SURFACE SOILS

FIGURE 13-2

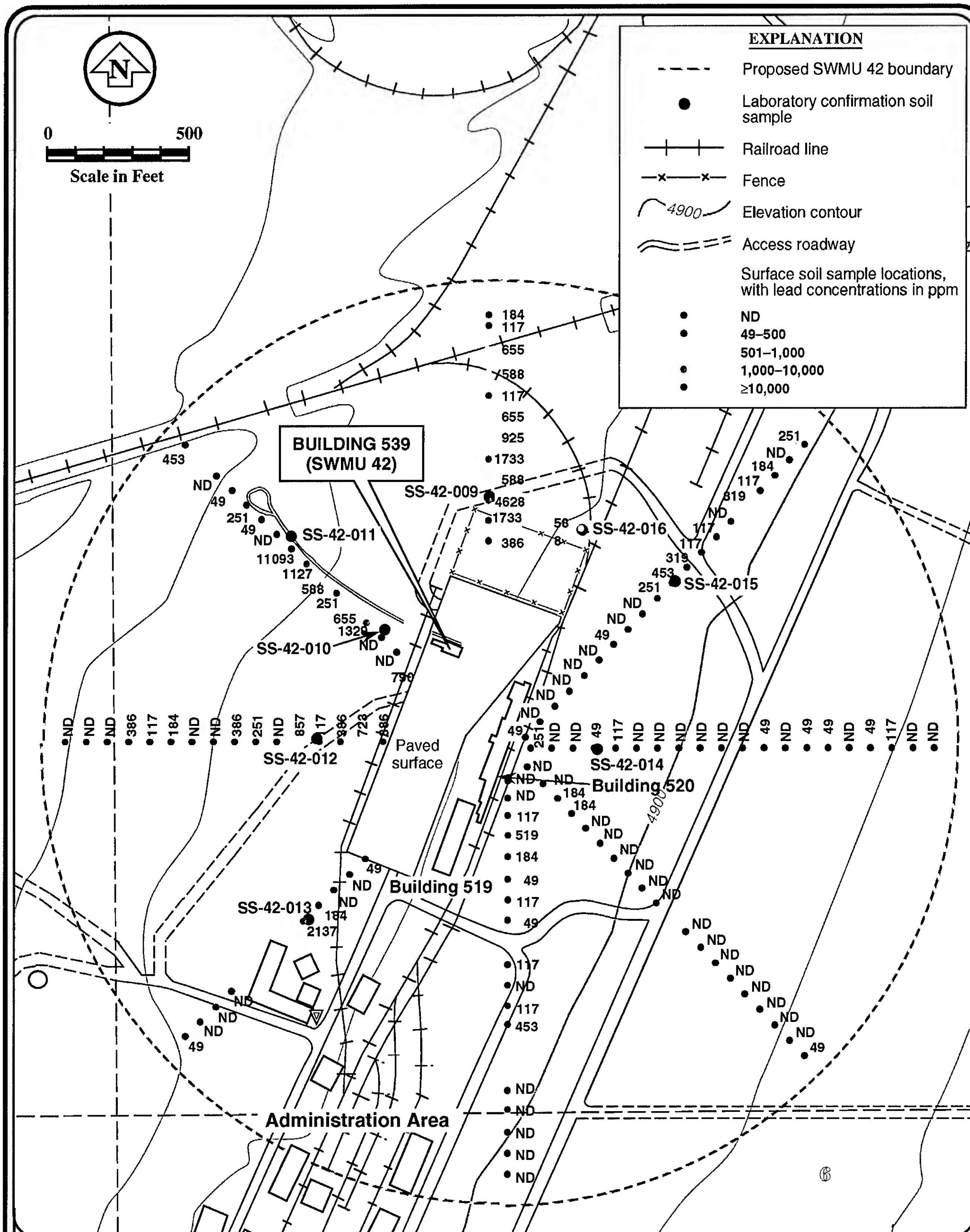
3

13.3.1.2. Results from the XRF field screening of the surface soils for lead and strontium are presented in Figure 13-3 and 13-4, respectively. An area with a radius of 1,500 feet, centered on the prominent smokestack central to Building 520, was investigated by means of eight transects, as shown. In general, the highest lead and strontium values detected by this method occurred along the transects to the north, northwest, and west of SWMU 42. These data correspond with the prominent wind directions at TEAD-N (i.e., from the south and southeast), as shown in the wind roses on Figure 2-6. Appendix G contains the report prepared by the XRF subcontractor, which presents the instrument response data, calibration curves, and analytical data from the XRF field screening activities.

13.3.1.3. Detections of explosives in the surface soils at SWMU 42 are limited to the compounds 2,4-DNT and 2,6-DNT in three surface soil samples, two 10-foot soil borings, and the surface interval of one 100-foot boring (Figure 13-5). With the exception of one surface soil sample, these detections are from locations along the wastewater ditch, holding pond, or concrete discharge flume along the north side of Building 539. Comparisons of the analytical results to an available risk-based soil guidance threshold (USEPA, 1994a) established for 2,4-DNT show that all 2,4-DNT concentrations are less than the risk-based residential scenario threshold.

13.3.1.4. The two shallow hand borings at SWMU 42, which were augered and sampled beneath two separate ash and debris piles and three additional surface samples showed low concentrations of several dioxin and furan isomers in the soil immediately beneath the piles. These compounds probably originated as combustion by-products in the demilitarization furnaces (from which the ash and debris piles originated). Comparison of the dioxin and furan results with available risk-based soil guidance thresholds (USEPA, 1994a) shows that the maximum 2,3,7,8-TCDD concentration exceeded its residential threshold, but not its commercial/industrial level. The maximum HXCDD concentration did not exceed either threshold. Figure 13-5 shows the locations of the two shallow auger borings, the three surface soil samples, and the dioxin/furan results.

13.3.1.5. Shallow Soils. Concentrations of contaminants detected in shallow subsurface soils (less than 12 feet deep) show that elevated levels of metals were also present at this depth, as illustrated in Figure 13-6. The metals concentrations in the subsurface soils are generally less than those in the surface soils and appear to be most common beneath the ditch and former evaporation pond and beneath the former location of the second furnace. Away from the ditch and holding pond, thallium was elevated above background in



Source: Modified from USGS Tooele 7.5 minute quadrangle.

TEAD-N RFI—GROUP A SWMUs

BOMB WASHOUT BUILDING—SWMU 42
XRF FIELD SCREENING LEAD RESULTS

FIGURE 13-3

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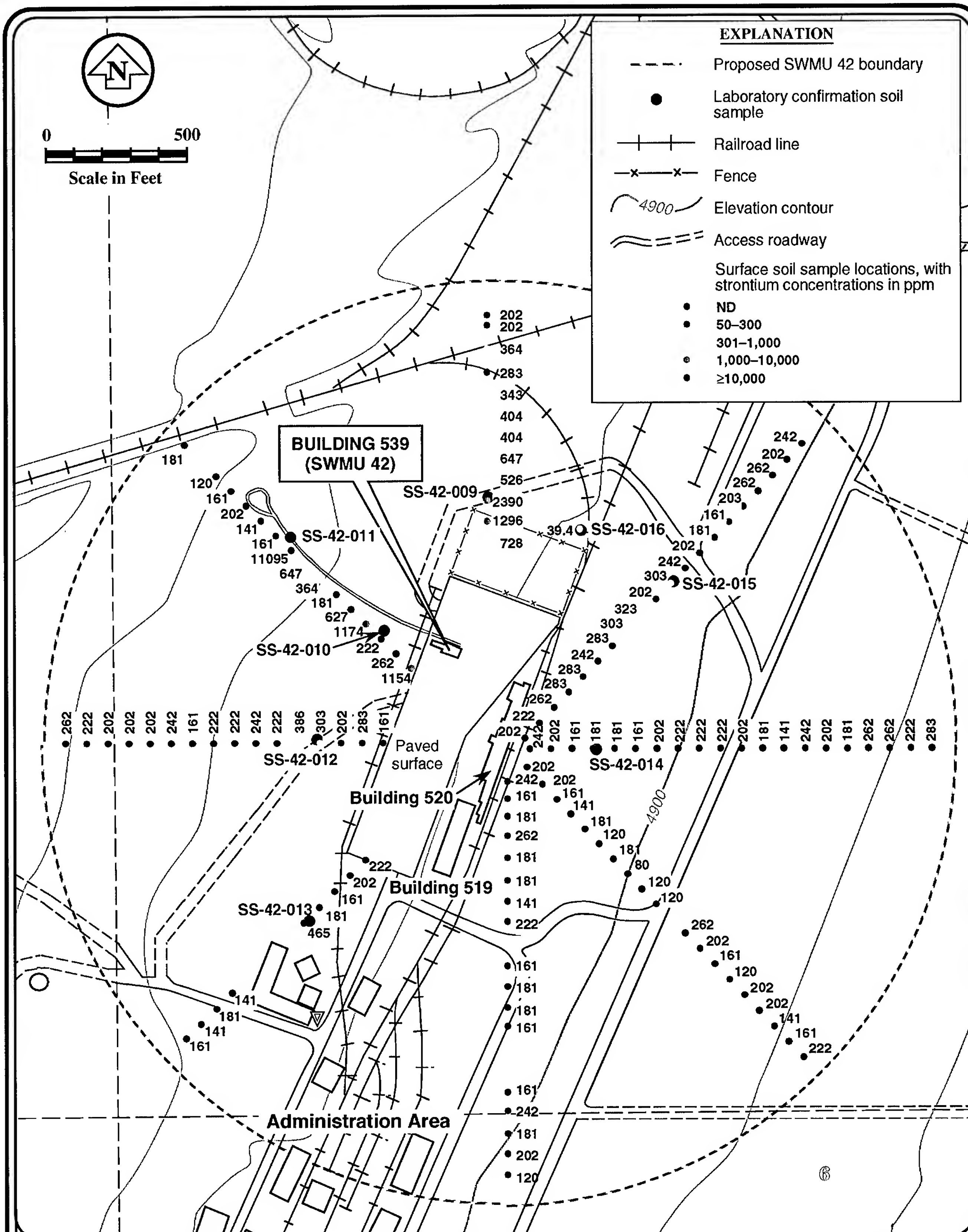

Source: Modified from USGS Tooele 7.5 minute quadrangle.

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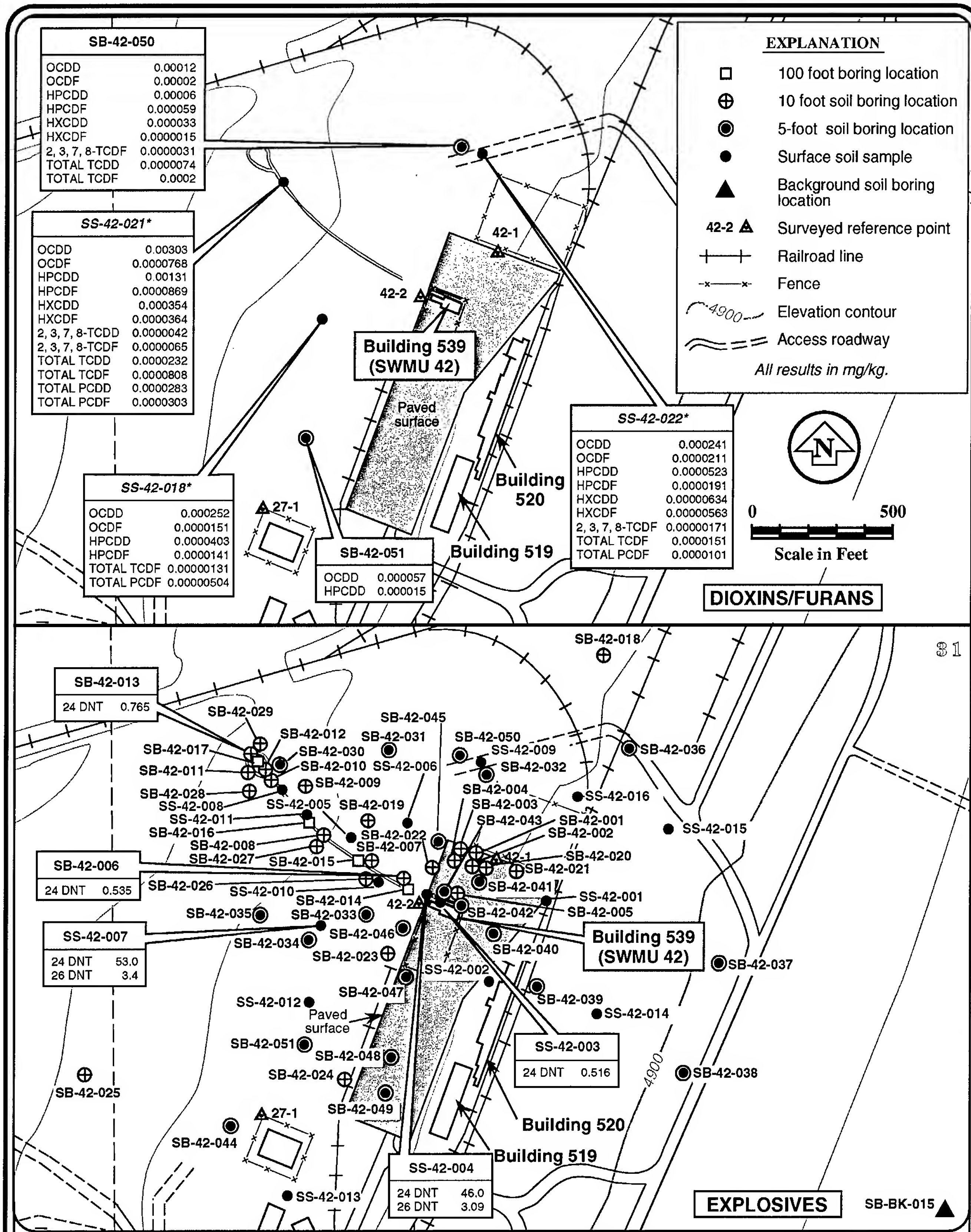
TEAD-N RFI—GROUP A SWMUs
BOMB WASHOUT BUILDING—SWMU 42
XRF FIELD SCREENING STRONTIUM RESULTS
FIGURE 13-4



Source: Modified from USGS Grantsville 7.5 minute quadrangle.
All results in mg/kg.

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
BOMB WASHOUT BUILDING—SWMU 42
ANALYTICAL RESULTS FOR
SURFACE SOIL SAMPLES
FIGURE 13-5

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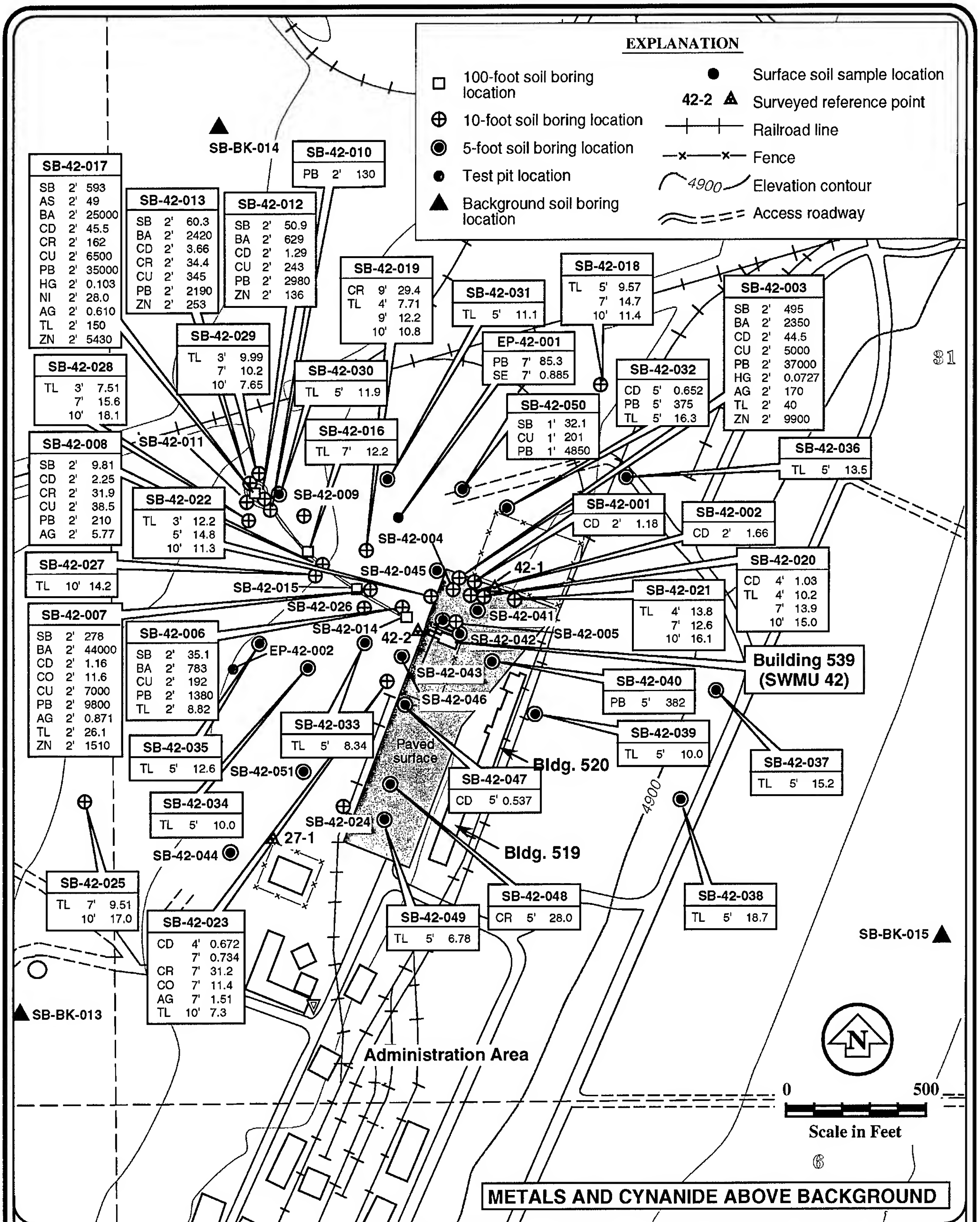

Source: Modified from USGS Tooele 7.5 minute quadrangle.
All results in mg/kg.

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
BOMB WASHOUT BUILDING—SWMU 42
ANALYTICAL RESULTS FOR
SHALLOW SOILS (< 10 FEET BGS)
FIGURE 13-6

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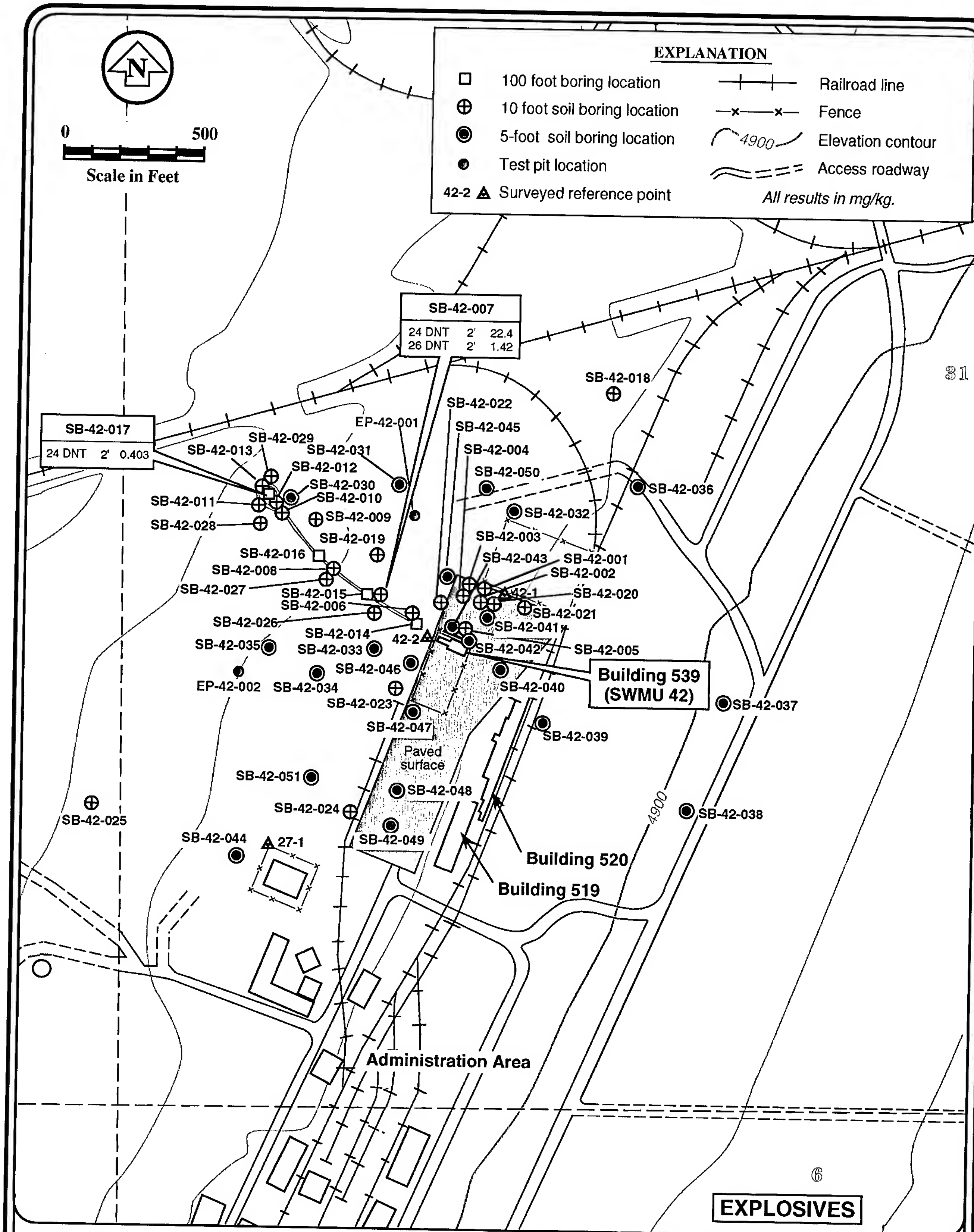
subsurface shallow soils with concentrations generally ranging from 10 mg/kg to 20 mg/kg.

13.3.1.6. Figure 13-7 shows the explosives results for shallow subsurface soils. Explosives detected in the shallow subsurface soils are limited to two detections of 2,4-DNT and one of 2,6-DNT from a depth of two feet bgs in two borings.

13.3.1.7. Deep Soils. Analyses of deep subsurface soils at SWMU 42 are limited to those from the four 100-foot deep boreholes drilled along the former wastewater ditch and in the holding pond. Figure 13-8 presents the results of the deep borehole sampling at SWMU 42. Thallium was found in concentrations above background in most of the sampled intervals in all four borings. However, the thallium detected in these borings is likely a result of naturally occurring background conditions in the deeper soils. Thallium is highly immobile in soils under normal environmental conditions (see discussion in Table 3-4). Therefore, if the thallium in the soils at SWMU 42 originated from an anthropogenic source, thallium concentrations would be excepted to decrease with increasing depth. This is not the case at SWMU 42; thallium concentrations are uniform between depth intervals (between 8 and 24 mg/kg), and there is not a trend of decreasing thallium concentration with increased depth suggesting that thallium concentrations are due to natural variations.

13.3.1.8. Air Monitoring. TSP filter samples were collected at four locations by means of high-volume TSP samplers. Samples were collected on a schedule of every sixth day over a two-month period (from early October to early December). The filter samples from each of the two 30-day periods were composited at the laboratory and analyzed for the TAL metals. This resulted in two sets of analytical results for the two-month period. The TSP sampling locations and the results for the first 30 days (October 1993) are shown on Figure 13-9, and results from the second round of sampling (November 1993) are shown on Figure 13-10. Appendix H contains the air monitoring subcontractor's report. Table 13-1 presents the sampling results from both rounds of sampling, and compares these results to available risk-based guidance criteria from four separate sources. These comparisons show that arsenic (as a carcinogen) and chromium (both trivalent and hexavalent states) may be of concern with respect to these indices. No background ambient air values for this area are available for comparisons.

13.3.1.9. Geophysical Investigation. A subsurface geophysical survey was conducted across an approximately 800-foot by 2,000-foot area immediately north and west of



Source: Modified from USGS Tooele 7.5 minute quadrangle.

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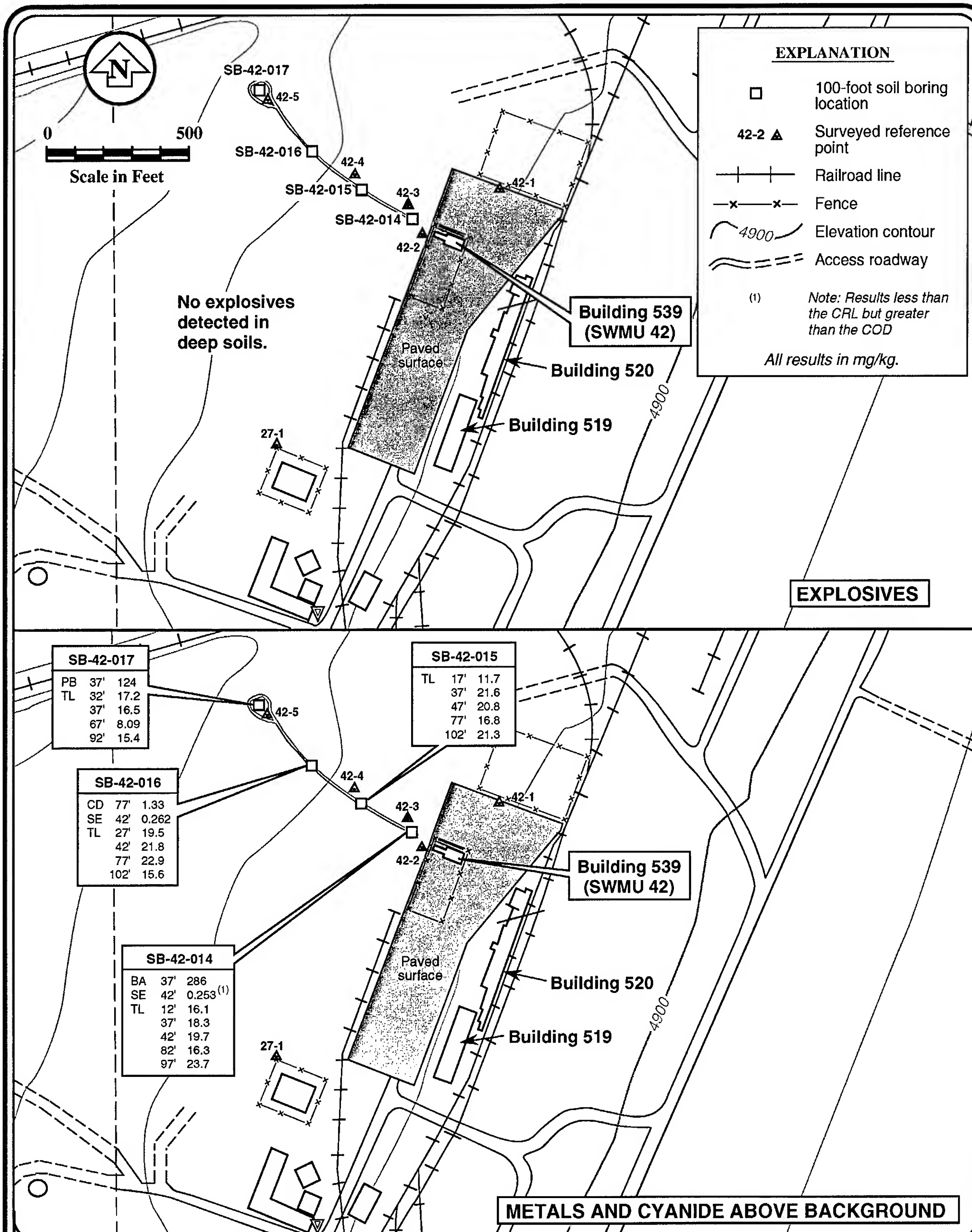
TEAD-N RFI—GROUP A SWMUs
BOMB WASHOUT BUILDING—SWMU 42
ANALYTICAL RESULTS FOR
SHALLOW SOILS (< 10 FEET BGS)
FIGURE 13-7



Source: Modified from USGS Tooele 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs

BOMB WASHOUT BUILDING—SWMU 42
ANALYTICAL RESULTS FOR DEEP SOILS (> 10 FEET BGS)

FIGURE 13-8

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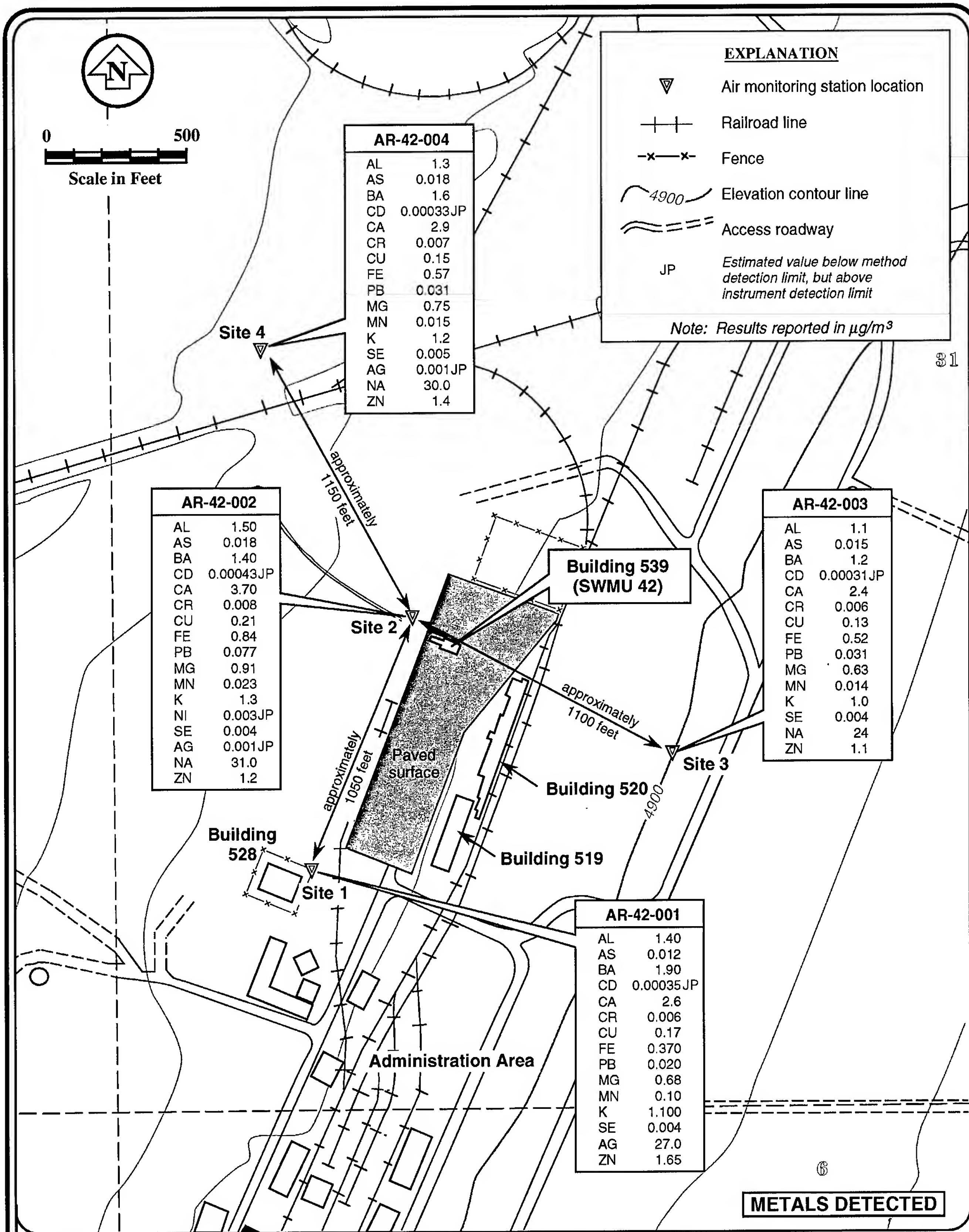

Source: Modified from USGS Tooele 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
BOMB WASHOUT BUILDING—SWMU 42
AIR MONITORING RESULTS
OCTOBER 1993
FIGURE 13-9

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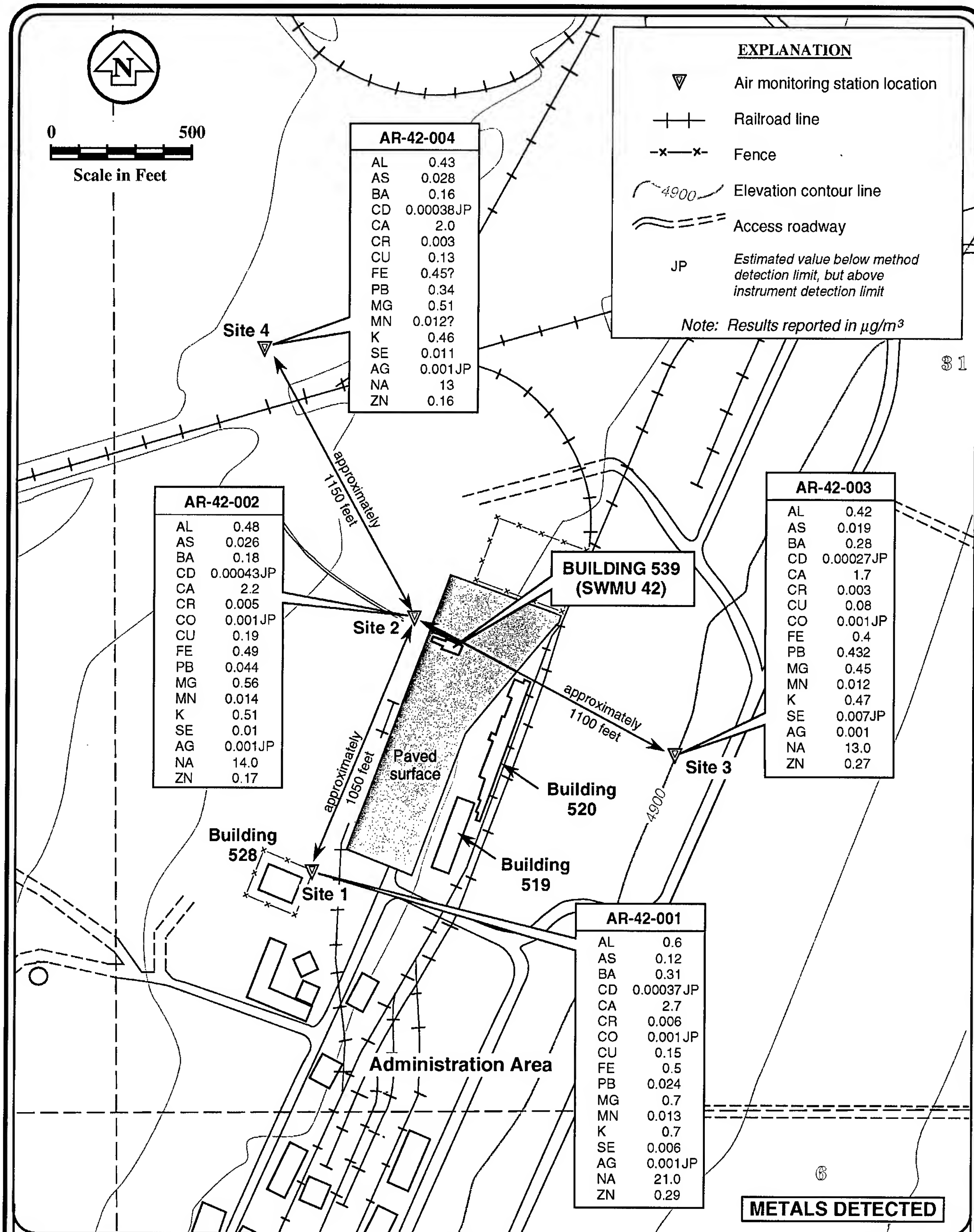

Source: Modified from USGS Tooele 7.5 minute quadrangle.

TEAD-N RFI—GROUP A SWMUs

BOMB WASHOUT BUILDING—SWMU 42

AIR MONITORING SAMPLES

NOVEMBER 1993

FIGURE 13-10

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TABLE 13-1

AIR SAMPLING RESULTS - TEAD-N SWMU 42

ANALYTE	ROUND	AR-42-001 µg/M3	AR-42-002 µg/M3	AR-42-003 µg/M3	AR-42-004 µg/M3	Blank µg/M3	LOD* µg/M3	Proposed Subpart S Action Levels (Air) (µg/M3)	Health-Based Criteria for Carcinogens (1) (µg/M3)	Health-Based Criteria for Systemic Toxicants (1) (µg/M3)	U.S.EPA Region III Guidance Table for Ambient Air (7/93) (2) (µg/M3)
Aluminum	1	1.4	1.5	1.1	1.3	0.53	0.005	--	--	--	11,000
	2	0.6	0.48	0.42	0.43	0.15	"				
Antimony	1	ND**	ND	ND	ND	ND	0.005	--	--	--	1.5
	2	ND	ND	ND	ND	ND	"				
Arsenic	1	*0.012*	*0.018*	*0.015*	*0.018*	*0.0052*	0.0003	0.00007	0.000232	--	1.1 (0.00053 as carcinogen)
	2	*0.012*	*0.026*	*0.019*	*0.028*	*0.00073*	"				
Barium	1	*1.9*	*1.4*	*1.3*	*1.6*	0.25	0.003	--	--	--	0.52
	2	0.31	0.18	0.28	0.16	0.0026	"				
Beryllium	1	ND	ND	ND	ND	ND	0.0003	0.0004	0.000417	--	0.00095
	2	ND	ND	ND	ND	ND	"				
Cadmium	1	0.00035	0.00044	0.0003	0.00033	0.00013	0.00003	0.0006	0.00045	--	0.0013
	2	0.00037	0.00044	0.00027	0.00038	0.00009	"				
Chromium	1	*0.0058*	*0.0079*	*0.0055*	*0.0065*	*0.0038*	0.0008	0.00009	0.000085	--	CrIII=0.0021; CrVI=0.00019
	2	*0.0058*	*0.0046*	*0.0034*	*0.0033*	0.002	"				
Cobalt	1	ND	ND	ND	ND	ND	0.0006	--	--	--	--
	2	0.001	0.00067	0.0012	ND	ND	"				
Copper	1	0.17	0.21	0.13	0.15	0.042	0.0008	--	--	--	140
	2	0.15	0.19	0.08	0.13	0.0035	"				
Iron	1	0.37	0.84	0.52	0.57	0.4	0.002	--	--	--	--
	2	0.5	0.49	0.4	0.45	0.029	"				
Lead	1	0.02	0.077	0.031	0.031	0.013	0.0001	--	--	--	--
	2	0.024	0.044	0.032	0.034	0.0014	"				
Manganese	1	0.01	0.023	0.015	0.015	0.011	0.0004	--	--	--	0.42
	2	0.013	0.014	0.012	0.012	0.00097	"				
Mercury	1	ND	ND	ND	0.00007	ND	0.00006	--	--	--	0.31
	2	ND	ND	ND	ND	ND	"				
Nickel	1	ND	ND	ND	ND	ND	0.003	--	0.00417	--	--
	2	ND	ND	ND	ND	ND					
Selenium	1	0.0036	0.0041	0.0035	0.0045	0.0007	0.0002	--	--	--	18
	2	0.0059	0.01	0.0074	0.011	0.00025	"				
Silver	1	ND	ND	ND	ND	ND	0.0005	--	--	--	18
	2	0.001	0.00088	0.00074	0.0009	ND	"				
Thallium	1	ND	ND	ND	ND	ND	0.0004	--	--	--	0.26 - 0.33 (compound-specific)
	2	ND	ND	ND	ND	ND	"				
Vanadium	1	ND	ND	ND	ND	ND	0.002	--	--	--	26
	2	ND	ND	ND	ND	ND	"				
Zinc	1	1.6	1.2	1.1	1.4	2.7	0.0006	--	--	--	1100
	2	0.29	0.17	0.27	0.16	0.0049	"				

* LOD=Limit of Detection
** ND=Not Detected above the LOD shown.
-- No Value Established
0.012 Value exceeds one or more regulatory criteria

(1) 40 CFR Section 264.521(a)(2)(i-iv)
(2) From Tables 8-6 and 8-7; "RCRA Facility Investigation (RFI) Guidance - Volume I"; EPA 530/SW-89-031; May 1989.
(3) From July, 1993 U.S.EPA memo re: toxicological guidance for risk-based screening at Superfund sites; R.L. Smith, Ph.D.

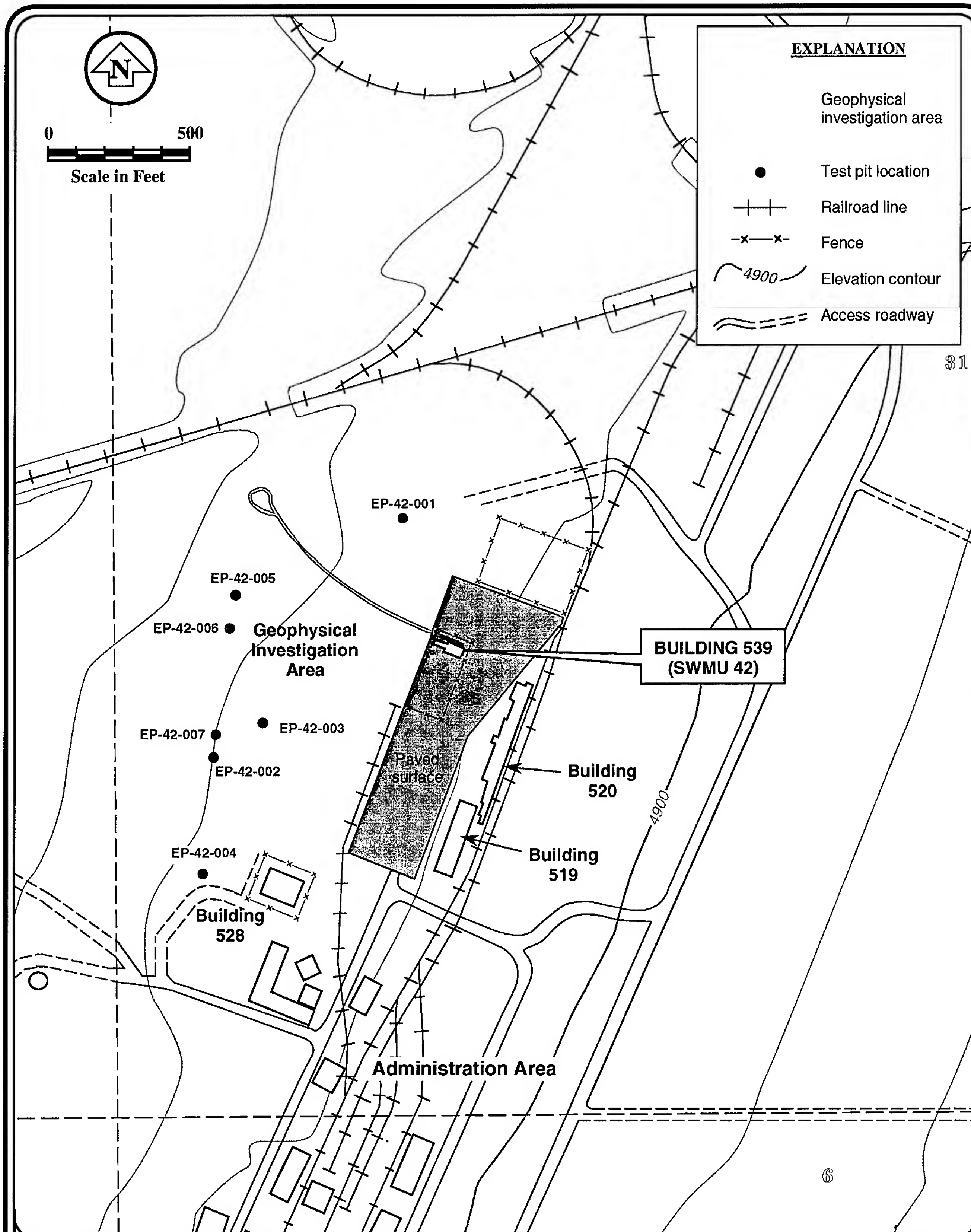
SWMU 42 using portable magnetometer, non-ferrous metal detection, and soil conductivity methods. Traverses of this area were made on a 15-foot spacing to investigate the possibility that buried material might be present as a result of previous disposal practices. Figure 13-11 shows the geophysical investigation area in relation to SWMU 42, and Appendix F presents the report provided by the geophysical subcontractor detailing the methodology and results of this survey.

13.3.1.10. The following summarize the results of the geophysical investigation and the subsequent test pit activities:

- Abundant surface debris including demilitarized bullets, brass, slag, ash, and other scrap was encountered during the traverses.
- No strong evidence of large-scale subsurface debris was seen by any of the geophysical methods used.
- Seven test pits were excavated and logged, and two test pits were sampled, based on geophysical anomalies showing some subsurface disturbance and presence of scattered debris. No evidence of burial or soil disturbance was seen below approximately 1 to 1-1/2 feet bgs. Detailed information regarding the size, sample locations, orientation, etc., of the test pits at SWMU 42 is presented on the test pit logs included in Appendix B.
- Numerous items of potentially unexploded ordnance were found.

13.3.2. Nature and Extent of Contamination

13.3.2.1. Several decades of demilitarization activities at SWMU 42 (including Buildings 519, 520, and associated facilities) have released hazardous constituents to the nearby surface and shallow subsurface soils. Metals contamination is especially prevalent in the areas near the former demilitarization operations in and near Building 539, including the former wastewater ditch and holding pond. Wash water discharges, wind, and dumping of furnace ash appear to have transported metals contamination away from the SWMU 42 facility for distances up to 1,000-1,500 feet. Ash and metal debris piles are scattered across the open field west of SWMU 42, extending as far as 1,000 feet to the north, northwest, west, and southwest from Building 539. Releases of metals and dioxin/furan compounds from some of these debris piles has occurred, but does not appear to have migrated below the surface soils. Explosive compounds are present, mainly along the wastewater ditch and concrete flume.



Source: Modified from USGS Tooele 7.5 minute quadrangle.

TEAD-N RFI—GROUP A SWMUs

BOMB WASHOUT BUILDING—SWMU 42
GEOPHYSICAL INVESTIGATION AREA

FIGURE 13-11

MONTGOMERY WATSON

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13.3.2.2. The possibility of explosive risk due to unexploded ordnance is also present in association with the surface debris. In order to reduce the explosive risk due to unexploded ordnance at SWMU 42, an unexploded ordnance handling and disposal subconsultant was contracted to locate any ordnance that might be encountered during field activities. Ordnance identified during the Phase II field activities included, 20mm projectiles, a 37mm projectile, cluster bomb submunition (two pieces), 57mm shell casings, 105mm shell casings, and numerous small arms ammunition. See the UXB report for SWMU 42 in Appendix N for a full report of ordnance discovery activities. UXB determined that the cluster bomb submunition could possibly be "live" so Base Ammo Operations personnel were contacted and an emergency detonation permit was issued. Ammo Operations then detonated the cluster bomb submunition on site. The 20mm and 37mm projectiles and the 57mm and 105mm shell casing were considered inert and left on site. Base Ammo Operations personnel also removed the live small arms ammunition for destruction at the OB/OD area.

13.3.2.3. Subsurface contamination is generally limited to shallow metals infiltration along the wastewater ditch and holding pond, and appears confined to the top few feet of soil, with the majority of elevated metals detections coming from the top two feet. Considering the previous effluent source and operational life of the wastewater ditch and holding pond, the subsurface metals and explosives infiltration is much less than expected. Detections of these analytes below two feet bgs are limited to slightly elevated levels of thallium, selenium, barium, and one each of lead and cadmium. Only thallium above background goes to total depth in the deep borings, and this probably reflects background conditions in the deep soils since thallium is not expected to have been present in the previous waste stream from Building 539.

13.3.3. Selection of COPCs and COPECs

13.3.3.1. Identification of COPCs. The selection of the COPCs for the Bomb Washout Building (SWMU 42) was based on the screening procedures and methodology outlined in Section 3.2.6. A summary of chemicals detected in samples from SWMU 42, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationale for the analytes not selected as COPCs is shown on Table 13-2.

13.3.3.2. Chemicals of potential concern selected for the human health risk assessment at SWMU 42 include the metals antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, manganese, mercury, and thallium. Organic chemicals of potential concern include the explosives 2,4-DNT and 2,6-DNT, and dioxins and furans.

TABLE 13-2

TEAD-N BASELINE RISK ASSESSMENT SCREEN FOR ANALYTES DETECTED IN SOIL AT SWMU 42–BOMB WASHOUT BUILDING

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluate in Risk Assessment	
			Human	Ecological
Aluminum	1.65E+04	100	No (a)	No (a)
Antimony	5.30E+03	17	Yes	Yes
Arsenic	7.70E+01	100	Yes	Yes
Barium	4.40E+04	100	Yes	Yes
Beryllium	3.00E+00	32	Yes	No (e)
Cadmium	8.94E+01	42	Yes	No (e)
Chromium	8.52E+02	100	Yes	Yes
Cobalt	3.45E+01	86	No (d)	No (e)
Copper	2.30E+04	100	Yes	Yes
Cyanide	3.21E+00	15	No (c)	No (e)
Lead	1.00E+05	75	Yes	Yes
Manganese	9.20E+02	100	Yes	Yes
Mercury	6.74E-01	14	Yes	Yes
Nickel	4.20E+02	100	No (c)	Yes
Silver	5.89E-01	17	No (c)	No (e)
Thallium	2.00E+02	68	Yes	Yes
Vanadium	1.94E+01	99	No (a)	No (a)
Zinc	9.90E+03	99	No (c)	Yes
2,4-Dinitrotoluene	5.30E+01	9	Yes	Yes
2,6-Dinitrotoluene	3.48E+00	4	Yes	No (e)
Dioxins/Furans	1.50E-05	100	Yes	Yes

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium
Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

(a) Analyte was detected at or below background concentrations
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte contributed less than 1 percent in a concentration - toxicity screen
(d) Low toxicity metal with inadequate toxicity data
(e) Maximum concentration less than NOAEL or estimation of NOAEL

13.3.3.3. Identification of COPECs. The COPECs were selected based on the criteria outlined in the methodology discussion (Section 3.2.7.). The COPECs that are evaluated in Tier 2 and the reason for the exclusion of analytes from further evaluation are presented in Table 13-2. The COPECs at SWMU 42 include eleven metals, the explosive 2,4-DNT, and dioxins and furans.

13.3.4. Contaminant Fate and Transport

13.3.4.1. As discussed in the previous section, the contaminants of concern at SWMU 42 in soil include metals and explosives (Table 13-2). In addition, dioxins and furans were detected in the ash piles. Table 3-4 briefly describes the fate and transport characteristics for the contaminants of concern identified in Table 13-2, as well as dioxins/furans. The remainder of this section presents a conceptual model of contaminant fate and transport at SWMU 42 and discusses the fate and transport of the contaminants of concern for soil and dioxins/furans.

13.3.4.2. Conceptual Model. A conceptual site model of contaminant transport has been developed (Figure 13-12) based on the physical site characteristics presented in Section 2.0 and the contamination assessment above. This model displays the potential routes of contaminant migration from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear unlikely based on available data. Contamination at SWMU 42 has been released to the surface soils from stack emissions, surface water and wash water runoff, and surface disposal of demilitarized materials at several locations to the west, north, and southwest of Building 539. The surface soils and shallow soils at SWMU 42 consist of gravelly sand, silty sand, and sandy and silty gravel. The groundwater is approximately 385 feet bgs, and the surface runoff is toward the west-northwest and is locally controlled by the waste water ditch that begins at Building 539 and extends westward approximately 600 feet to the former holding pond area (see Figure 13-1).

13.3.4.3. Fate and Transport of Metals. In general, transport of metals from the surface soils through the deeper soil horizons to groundwater is not expected at SWMU 42 based on the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow soils, neutral to slightly basic pH soils, and depth to groundwater (approximately 385 feet below the ground surface). Migration of metal contaminants via the surface-water drainage ditch appears to be an important transport

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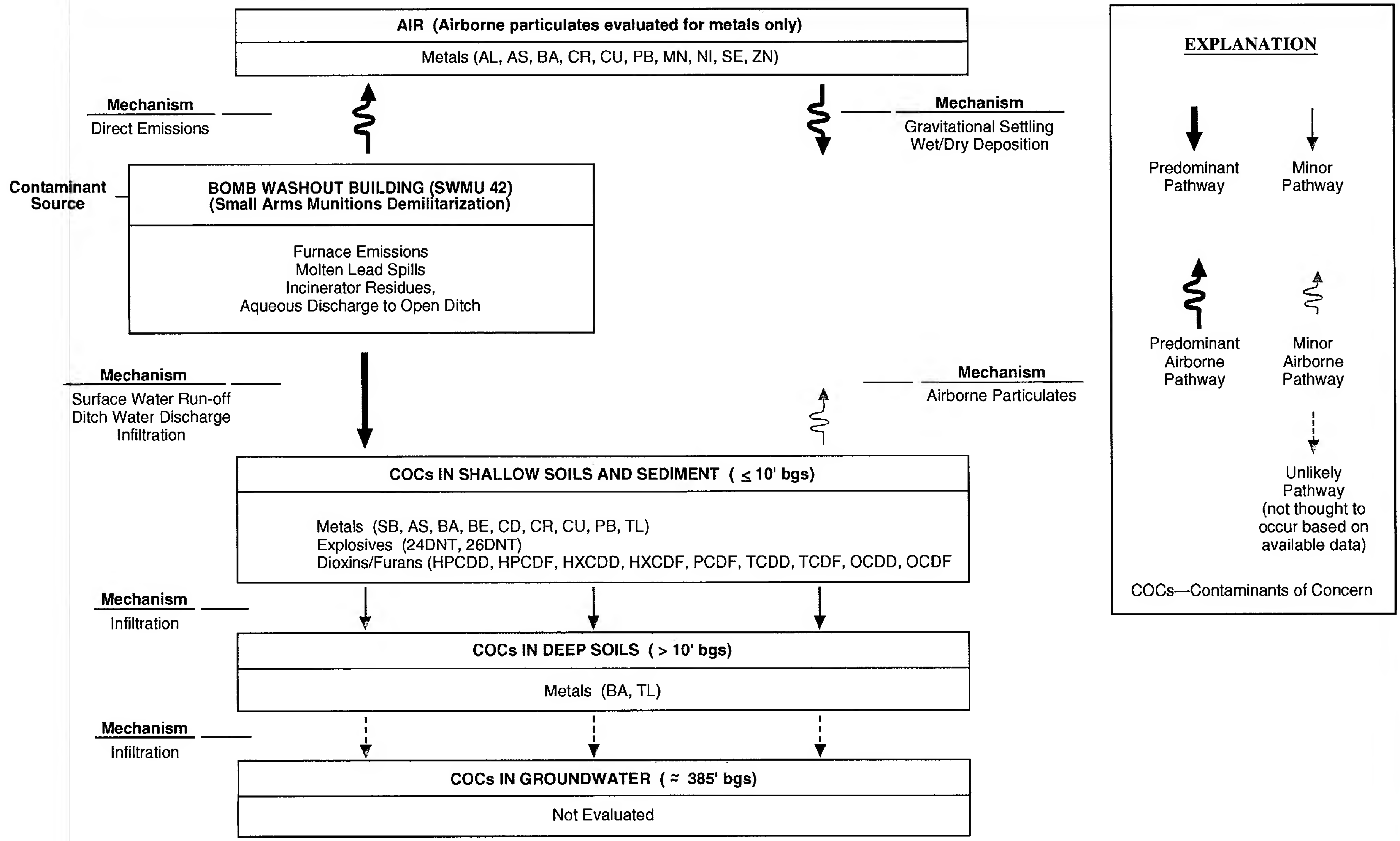

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TEAD-N RFI—GROUP A SWMUs
BOMB WASHOUT BUILDING—SWMU 42
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 13-12

pathway. However, during former operations at SWMU 42, wash water was frequently discharged to the waste water ditch and ultimately to the former holding pond, providing a potential driving mechanism for metals transport at this site. Deep soil borings drilled to 100 feet bgs along the waste water ditch and within the former holding pond have indicated that elevated metal concentrations generally have not extended beyond 10 feet bgs. Several borings drilled to 5 feet and 10 feet bgs along the same area do not show elevated metals below 2 feet bgs. Those metals that have exceeded background levels at depths greater than 10 feet bgs can be attributed to natural variations in the deeper subsurface soils and likely do not represent metals contamination resulting from SWMU 42 activities (see Section 13.3.2.). In summary, elevated concentrations of several contaminants have been detected in soils in the waste water ditch and holding pond, but little vertical migration of metals has been identified along the waste water ditch and in the holding pond area. The metal contaminants in the surface soils have been shown to provide particulates to the air pathway at this site, and these particulates have been transported at least 1100 feet from the source.

13.3.4.4. Fate and Transport of Explosives. Explosive compounds in the environment are generally mobile; they tend to leach, volatilize from, and diffuse through surface and shallow soils. Explosives at the concentrations detected up to 53 mg/kg would suggest that there is only a low potential for leaching of explosives to the deep soil horizons (i.e., >10 feet bgs) or the groundwater. Attenuation of the explosives in surface soils would be expected through volatilization or by photolytic transformations, while in subsurface soils, attenuation would be expected by very slow biodegradation. Migration of explosive contaminants via surface-water drainage along the waste water ditch appears to be a transport pathway but not to the extent it is for the transport of metals.

13.3.4.5. Fate and Transport of Dioxins and Furans. Several dioxin and furan compounds have been detected in low concentrations beneath the ash piles at SWMU 42. These compounds were detected at the surface and in the shallow subsurface (at 1 foot bgs). Dioxins and furans are expected to strongly adsorb to the soil and be immobile, so there is little potential for these compounds to leach under normal environmental conditions. In addition, the concentrations of the dioxins and furans are observed to be either below the reporting limit or one or more orders of magnitude less in the sample collected at 1 foot bgs, than in the surface sample collected directly beneath the ash pile. Surface water runoff will have only very local transport effects because these contaminants tend to strongly adsorb to sediments, and because precipitation rates are low. The surface contaminants may provide particulates to the air pathway. Dioxins and furans are expected to be persistent in the environment.

13.4 HUMAN HEALTH RISK ASSESSMENT

13.4.0.1. The methods used to estimate the risks associated with SWMU 34 are given in Human Health Risk Assessment Methodology, Section . .2.6. The COPCs were identified in the previous section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 42) is presented in the following sections.

13.4.1. Exposure Pathways and Receptors

13.4.1.1. The pathways quantitatively evaluated in the BRA are: (1 ›se that are complete or likely to be completed in the future, and (2) those that may potentially cause a significant risk. An evaluation of completeness is shown on Figure 13- , which is a diagram of exposure pathways for SWMU 42. An evaluation of pathwa ompleteness and an assessment of whether a pathway is significan enough to require further evaluation for current and potential future receptors at SWMU 42 is give n Tables 13-3 and 13-4, respectively.

13.4.1.2. The Marines who work at SWMU 42 are current on-Depot receptors. Presently both regular and reserve unit Marines utilize the facility. re are six regular Marines who work five days per week for a three-year assignment. The reservists are at the facility for approximately seven days each month. A secon roup of approximately 120 reservists are on site one day per month, for up to 20 years. he majority of time is spent indoors in a garage doing vehicle and equipment maintenance. Some maintenance is conducted outside in the parking area.

13.4.1.3. Personnel (both military and civilian) live in d housing about 340 meters south of SWMU 42, and could inhale fugitive dust ated from this SWMU. According to the Tooele housing office, people live in the housing a maximum of five years. Other people who could inhale fugitive dust from SWMU 42 include residents of Stockton (4.5 miles to the south) and Grantsville (8.5 mile to the northwest).

13.4.1.4. Potential future on-Depot receptors for contaminants originating from SWMU 42 include construction workers and TEAD-N residents. Construction workers may be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For construction workers, direct exposure results from the anticipated excavation activities associated with construction or demolition of a building, and includes both surface and subsurface soil to a depth of 10 feet (contact with deeper soil is highly

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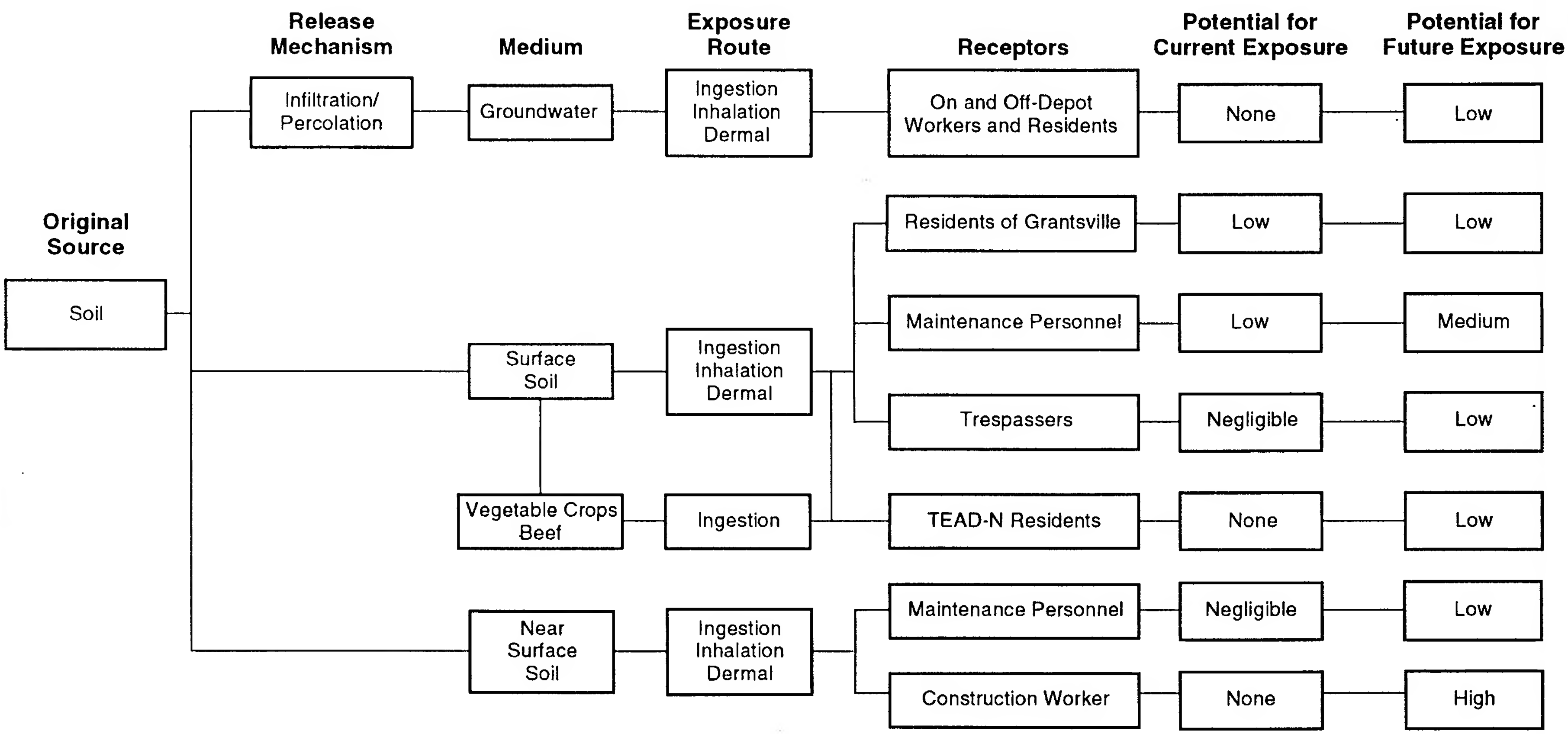

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TEAD-N RFI—GROUP A SWMUs
BOMB WASHOUT BUILDING—SWMU 42
EXPOSURE PATHWAYS DIAGRAM
FIGURE 13-13

TABLE 13-3

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 42: BOMB WASHOUT BUILDING

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is estimated to be 385 feet below the below ground surface, and evapotranspiration is high.
Surface Water and Sediment	Depot Personnel	Incidental ingestion and dermal contact with water or sediment	No. The holding pond is 800 feet from the nearest building and there is no evidence of human activity in the area. The building wash-down water is no longer discharged to the holding pond. The pond area is dry except immediately following heavy precipitation.
Soil			
Surface Soil	Residents of Grantsville, Stockton, and Depot Housing	Inhalation of fugitive dust	Yes. Surface soil is contaminated.
	Maintenance Personnel	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Surface soil is contaminated and although unpaved areas are off-limits to Depot personnel, the scenario will be evaluated as if personnel have contact with soil.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers have not been observed at this area.
Near-Surface Soil	Maintenance Personnel	Incidental ingestion of dust, inhalation, and dermal contact	No. While near-surface soil is contaminated, personnel do not engage in intrusive activities such as excavations.
Air	Maintenance Personnel	Inhalation of volatile organics from subsurface soil	No. Contaminants are not volatile. Dust exposure evaluated under soil.

TABLE 13-4

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 42: BOMB WASHOUT BUILDING

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely to result in the future. Groundwater is estimated to be 385 feet below the below ground surface, and evapotranspiration is high.
Surface Water and Sediment	Future residents	Incidental ingestion, dermal contact with water or sediment	No. Surface water is rarely present.
Soil			
Surface Soil	Residents of Grantsville, Stockton, and Depot Housing	Inhalation of fugitive dust	No. Pathway was evaluated under current conditions.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. While this SWMU is not within the existing closure parcel, residential development would be possible if this area of the Depot was closed in the future. Surface soil is contaminated.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers are not expected and the exposure would be less than for a future resident.
Near-Surface Soil	Construction worker	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Near-surface soil is contaminated and future land use is uncertain.
Air	Future TEAD-N residents	Inhalation of volatile organics from subsurface soil	No. Contaminants are not volatile. Dust exposure evaluated under soil.

TEAD-N Tooele Army Depot North Area

unlikely and there is also lower concentrations of COPCs below this depth). Should this portion of the Depot be closed in the future residents (it is not slated for closure at this time), future residents could become receptors and be exposed to contaminants in surface soil by ingestion, dermal contact, and inhalation of dust. While there are no current plans to convert SWMU 42 into a residential development, a residential scenario was evaluated as per the requirements of UAC 315-101 (1994).

13.4.1.5. SWMU 42 could be converted into an area where crops are grown and future residents could eat the fruits and vegetables that are grown. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. These pathways are evaluated as part of the future residential scenario.

13.4.1.6. For the pathways evaluated quantitatively (see Tables 13-3 and 13-4), site-specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are given in Appendix K.

13.4.2. Risk Characterization

13.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 42. The methods for calculating the risks are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

13.4.2.2. Typically, an excess lifetime cancer risk of less than 1 x 10^{-6} is acceptable (unless there are reasons to believe the risks have been underestimated), a risk greater than 1 x 10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects are possible. An adult blood lead level between 10 and 15 micrograms per deciliter (µg/dl) is a benchmark range based on hypertension in adult males and transfer of lead from a pregnant mother to her fetus. For children, 10 µg/dl is the benchmark typically used by the EPA (USEPA, 1994; see Section 3.2.6. for a discussion of the calculation of blood lead concentrations for adults and children).

13.4.2.3. In addition to the calculated estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed and the degree of confidence in the risk estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for current maintenance personnel, and potential future construction workers and TEAD-N residents.

13.4.2.4. Maintenance Personnel. As shown on Table 13-5, the excess lifetime cancer risk for the Marines performing maintenance work at SWMU 42 was estimated to be 2×10^{-6}, which is above the benchmark risk of 1×10^{-6}. Approximately one half of the calculated cancer risk is from ingestion of arsenic. The total hazard index for maintenance personnel is 3 and the concentration of lead in blood is estimated to be 18.1 µg/dl. The hazard index is above the benchmark of 1 and the blood lead concentration is higher than the benchmark concentration range of 10 to 15 µg/dl.

13.4.2.5. The significance of this current pathway is diminished by the fact that people do not currently work in or around the former wastewater ditch, where most of the samples have been collected and where XRF measurements indicate lead concentrations are the highest. However, in the absence of institutional controls, people might work in the vicinity of the former wastewater ditch in the future.

13.4.2.6. There are factors that both increase and decrease the significance of the cancer risk estimates. If SWMU 42 was ever included in a portion of the Depot that was closed and a private business were to open, the exposure duration would be expected to be longer than the assumed three years for some workers. If a duration of 25 years was assumed, the estimated cancer risk would be about 1×10^{-5} (the hazard index and blood lead concentration estimates would be unchanged). The significance of the cancer risk is increased by the fact that arsenic and chromium are Class A (known human) carcinogens, and they account for about two thirds of the cancer risk estimate. Other factors, however, indicate that the potential cancer risk is actually lower than estimated. First, contaminant concentrations in air are probably overestimates by about an order of magnitude (see the discussion of uncertainties in Section 13.4.3.). The COPC concentrations used in other pathways are probably overestimates as well. Second, the soil ingestion rate is probably high by a factor of two (again, see the discussion of uncertainties). The net result of all of these considerations is that a potential cancer risk below 1×10^{-6} is likely for a worker

TABLE 13-5

SWMU 42 - BOMB WASHOUT BUILDING
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR MAINTENANCE PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	2.1E+01	8E-07	3E-08	7E-08	9E-07	52
Beryllium	5.7E-01	5E-08	4E-08	1E-09	1E-07	6
Cadmium	1.2E+01	NC	NC	2E-08	2E-08	1
Chromium(VI)	2.8E+01	NC	NC	2E-07	2E-07	14
2,4-Dinitrotoluene	5.6E+00	8E-08	1E-07	NC	2E-07	12
2,6-Dinitrotoluene	5.9E-01	8E-09	1E-07	NC	1E-07	8
Dioxins/Furans	1.5E-05	5E-08	7E-08	5E-10	1E-07	7
Pathway Total		1E-06	4E-07	3E-07		
Percent of Total		57	24	19		
				Total Cancer Risk	**2E-06**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	3.9E+02	5E-01	2E+00	[illegible]	3E+00	91
Arsenic	2.1E+01	3E-02	2E-03	NC	4E-02	<1
Barium	4.7E+03	3E-02	3E-02	2E-02	8E-02	3
Beryllium	5.7E-01	6E-05	5E-05	NC	1E-04	<1
Cadm[illegible]	1.2E+01	6E-03	4E-03	NC	9E-03	<1
Chromium(VI)	2.8E+01	7E-04	3E-04	NC	1E-03	<1
Chromium(III)	1.1E+02	5E-05	6E-05	NC	1E-04	<1
Lead	1.2E+04	NC	NC	NC	NC	NC
Manganese	3.0E+02	1E-03	2E-03	1E-01	1E-01	<1
Mercury	7.3E-02	1E-04	3E-05	4E-06	2E-04	<1
Thallium	2.5E+01	2E-02	7E-04	NC	2E-02	1
2,4-Dinitrotoluene	5.6E+00	1E-03	2E-03	NC	4E-03	<1
2,6-Dinitrotoluene	5.9E-01	3E-04	5E-04	NC	8E-04	<1
Pathway Total		6E-01	2E+00	1E-01		
Percent of Total		20	75	4		
				Total Hazard Index:	**3E+00**	
	Blood Lead Concentration µg/dl (95th percentile):				**18.1**	

CR	Cancer risk
HI	Hazard index
NA	Not applicable
NC	Not calculated
RME	Reasonable maximum exposure

present at a job for three years, but a risk between 1 x 10^{-5} and 1 x 10^{-6} would be probable for a worker with a 25-year exposure duration, assuming the employee worked by the wastewater ditch. The CTE cancer risk estimate based on a three-year exposure duration, was 5 x 10^{-7}, which agrees with this analysis (Table 13-6). A summary of the risk estimates and the qualitative factors affecting these estimates is presented in Table 13-7.

13.4.2.7. The blood lead level is based on a model which is not overly conservative. Parameters are generally central tendencies, rather than reasonable maximums. The lead at SWMU 42 was originally in the form of dust particles, and it is reasonable to expect that it has a high bioavailability. Because the Marines do not work in the former wastewater ditch where the highest lead concentrations have been detected, the blood lead level estimates do not apply to them. However, a blood lead concentration in excess of 15 μg/dl for a worker in the former wastewater ditch would not be an unlikely outcome. Because hypertension has been documented in middle-aged men whose blood lead level exceeded 15 μg/dl, the significance of the blood lead concentration estimate is high.

13.4.2.8. Because of the lack of inhalation reference doses for several metals, the inhalation pathway is largely unaccounted for in the estimate of the hazard index. However, the exposure doses are in a range where adverse health effects are unlikely (see the discussion of uncertainties in Section 13.4.3.; Appendix K summarizes the exposure doses). Consequently, the absence of inhalation reference doses is not thought to result in a significant underestimate of the total hazard index. The hazard index is affected most by dermal exposure to antimony. This result is biased high by the soil adherence rate and the assumption that all exposed skin is covered with soil. These uncertainties make it likely that a more accurate estimate of the hazard index is less than 1. The CTE estimate of the hazard index was 0.6.

13.4.2.9. Residents of Grantsville, Stockton, and Depot Housing. The excess lifetime cancer risk from inhalation of fugitive dust was estimated to equal 1 x 10^{-8} for residents of Grantsville and Stockton, and 8 x 10^{-7} for depot housing residents (Table 13-8). The hazard index was estimated to equal 0.004, 0.003, and 0.4 for residents of Grantsville, Stockton, and depot housing, respectively. While evaluated as a currently complete pathway, the soil at SWMU 42 is crusted over, and dust is only expected when the crust is disturbed (such as when a vehicle drives over the soil). It was assumed that such a disturbance occurs once per week; this assumption is considered highly conservative.

TABLE 13-6

SWMU 42 - BOMB WASHOUT BUILDING
CTE CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR MAINTENANCE PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	2.1E+01	4E-07	5E-09	2E-10	4E-07	72
Beryllium	5.7E-01	2E-08	7E-09	4E-12	3E-08	6
Cadmium	1.2E+01	NC	NC	6E-11	6E-11	<1
Chromium(VI)	2.8E+01	NC	NC	8E-10	8E-10	<1
2,4-Dinitrotoluene	5.6E+00	4E-08	2E-08	NC	6E-08	11
2,6-Dinitrotoluene	5.9E-01	4E-09	2E-08	NC	3E-08	5
Dioxins/Furans	1.5E-05	2E-08	1E-08	2E-12	3E-08	6
Pathway Total		4E-07	7E-08	1E-09		
Percent of Total		87	13	<1		
				Total Cancer Risk	**5E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	3.9E+02	2E-01	3E-01	NC	5E-01	92
Arsenic	2.1E+01	2E-02	2E-04	NC	2E-02	<1
Barium	4.7E+03	1E-02	4E-03	8E-05	2E-02	3
Beryllium	5.7E-01	2E-05	7E-06	NC	3E-05	<1
Cadmium	1.2E+01	3E-03	6E-04	NC	3E-03	<1
Chromium(VI)	2.8E+01	3E-04	4E-05	NC	3E-04	<1
Chromium(III)	1.1E+02	2E-05	9E-06	NC	3E-05	<1
Lead	1.2E+04	NC	NC	NC	NC	NC
Manganese	3.0E+02	5E-04	2E-04	4E-04	1E-03	<1
Mercury	7.3E-02	5E-05	5E-06	1E-08	6E-05	<1
Thallium	2.5E+01	7E-03	1E-04	NC	7E-03	1
2,4-Dinitrotoluene	5.6E+00	6E-04	4E-04	NC	1E-03	<1
2,6-Dinitrotoluene	5.9E-01	1E-04	8E-05	NC	2E-04	<1
Pathway Total		3E-01	3E-01	4E-04		
Percent of Total		43	57	<1		
				Total Hazard Index:	**6E-01**	
		Blood Lead Concentration µg/dl (50th percentile):			**10.2**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
CTE Central Tendency exposure

TABLE 13-7

TEAD-N BASELINE RISK ASSESSMENT
SWMU 42–BOMB WASHOUT BUILDING PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (µg/dl)	Key Chemicals(a)
Maintenance Personnel					18.1	
Ingestion	Current likely	Medium/High	0.6	1×10^{-6}		Arsenic, antimony, chromium, lead, 2,4-dinitrotoluene
Dermal	Current likely	Medium/High	2	4×10^{-7}		
Inhalation	Current likely	High/High	0.1	3×10^{-7}		
Grantsville Residents						
Inhalation	Current unlikely	Medium/High	0.004	1×10^{-8}	NC	Arsenic, barium, chromium, manganese
Stockton Residents						
Inhalation	Current unlikely	Medium/High	0.003	1×10^{-8}	NC	Arsenic, barium, chromium, manganese
Depot Housing Residents						
Inhalation	Current unlikely	Medium/High	0.4	8×10^{-7}	NC	Arsenic, barium, chromium, manganese
Construction Worker					16.2	
Ingestion	Future likely	Medium/High	1	1×10^{-6}		Antimony, arsenic, chromium, lead, manganese
Dermal	Future likely	High/High	1	1×10^{-7}		
Inhalation	Future likely	Medium/High	1	2×10^{-6}		
TEAD-N Resident					54	
Ingestion	Future unlikely	Medium/High	20	7×10^{-5}		Antimony, lead, 2,4-dinitrotoluene, 2,6-dinitrotoluene
Dermal	Future unlikely	High/High	9	7×10^{-6}		
Inhalation	Future unlikely	High/High	2	8×10^{-6}		
Vegetable Crops	Future unlikely	High/High	200	3×10^{-2}		
Beef	Future unlikely	High/Neutral	0.03	1×10^{-7}		

TEAD-N Tooele Army Depot North Area
NC Not calculated
(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

TABLE 13-8

SWMU 42 - BOMB WASHOUT BUILDING
CANCER RISK CURRENT RESIDENTS

Cancer Risk

Chemical	RME Concentration (mg/kg)	Inhalation Cancer Risk Grantsville	Stockton	Depot Housing	Chemical Percent of Total CR
Arsenic	2.1E+01	3E-09	3E-09	2E-07	21
Beryllium	5.7E-01	5E-11	4E-11	3E-09	0.3
Cadmium	1.2E+01	7E-10	6E-10	4E-08	5
Chromium (VI)	2.8E+01	1E-08	9E-09	6E-07	74
2,4-Dinitrotoluene	5.6E+00	NC	NC	NC	NC
2,6-Dinitrotoluene	5.9E-01	NC	NC	NC	NC
Dioxins/Furans	1.5E-05	2E-11	2E-11	1E-09	0.1
Total Cancer Risk:		**1E-08**	**1E-08**	**8E-07**	

Hazard Index (Child)

Chemical	RME Concentration (mg/kg)	Inhalation Hazard Index Grantsville	Stockton	Depot Housing	Chemical Percent of Total HI
Antimony	3.9E+02	NC	NC	NC	NC
Arsenic	2.1E+01	NC	NC	NC	NC
Barium	4.7E+03	3E-03	2E-03	3E-01	69
Beryllium	5.7E-01	NC	NC	NC	NC
Cadmium	1.2E+01	NC	NC	NC	NC
Chromium (VI)	2.8E+01	NC	NC	NC	NC
Chromium (III)	1.1E+02	NC	NC	NC	NC
Lead	1.2E+04	NC	NC	NC	NC
Manganese	3.0E+02	1E-03	1E-03	1E-01	31
Mercury	7.3E-02	5E-08	4E-08	5E-06	0
Thallium	2.5E+01	NC	NC	NC	NC
2,4-Dinitrotoluene	5.6E+00	NC	NC	NC	NC
2,6-Dinitrotoluene	5.9E-01	NC	NC	NC	NC
Total Hazard Index:		**4E-03**	**3E-03**	**4E-01**	

CR Cancer risk
HI Hazard index
NC Not calculated
NA Not applicable
RME Reasonable maximum exposure

Blood lead levels were not modeled for these receptors because the highest average lead concentration in dust was estimated to equal 0.08 $\mu g/m^3$, which is less than the default assumption in the blood lead models.

13.4.2.10. Possible sources of risk underestimates include the absence of inhalation reference doses for several COPCs and the assumed exposure duration for residents of depot housing. Exposure doses for compounds without reference doses are on the order of 10^{-6} mg/kg/day or lower; these doses are not expected to be associated with a hazard index greater than 1. The exposure duration of five years assumed for residents of depot housing was based on conversations with staff at the TEAD Housing Office. If residents were to live 30 years, the cancer risk would increase by a factor of 2 (the increase is not proportional to the increase in exposure duration because the actual five year duration was applied to children, whereas the additional 25 years of exposure would mostly assume exposure parameters appropriate for adults). Because of the conservativeness of the dust generation and dispersion modeling, as well as the inhalation rate (see Section 13.4.3.), it is unlikely that dust from SWMU 42 poses a significant risk to current residents.

13.4.2.11. Potential Future Construction Worker. The excess lifetime cancer risk for potential future construction workers was estimated to equal 3×10^{-6} (Table 13-9). Most of the risk is generated by the inhalation of hexavalent chromium in dust and, to a lesser extent, the ingestion of arsenic. The total hazard index for potential future construction workers was estimated to equal 4 and the concentration of lead in blood was estimated to be 16.2 $\mu g/dl$. Most of the calculated hazard index originates from ingestion and dermal exposures to antimony, and inhalation of manganese.

13.4.2.12. The significance of the risk estimates is increased by the fact that there is a reasonable potential for construction work to occur at SWMU 42 in the future. The cancer risk estimate is made more significant by the fact that arsenic and hexavalent chromium are both Class A (known human) carcinogens. However, the actual cancer risk is above 1×10^{-6} only if (1) dust levels approach 1 mg/m^3 during construction; (2) soil ingestion levels approach 480 mg/day; and (3) the concentrations of COPCs are near the values used in this BRA (i.e., not biased high by the sampling locations). It is unlikely that all of these assumptions are correct, and the actual cancer risk is probably less than 1×10^{-6}. This is confirmed by the CTE evaluation (Table 13-10), which resulted in a cancer risk of 1×10^{-6}, and does not account for biased sampling locations.

TABLE 13-9

SWMU 42 - BOMB WASHOUT BUILDING
RME CANCER RISK AND HAZARD INDEX FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.3E+01	8E-07	7E-09	3E-07	1E-06	35
Beryllium	4.0E-01	6E-08	1E-08	5E-09	7E-08	2
Cadmium	6.6E+00	NC	NC	6E-08	6E-08	2
Chromium(VI)	2.8E+01	NC	NC	2E-06	2E-06	53
2,4-Dinitrotoluene	3.5E+00	8E-08	3E-08	NC	1E-07	4
2,6-Dinitrotoluene	4.6E-01	1E-08	3E-08	NC	4E-08	1
Dioxins/Furans	1.5E-05	7E-08	2E-08	3E-09	1E-07	3
Pathway Total		1E-06	1E-07	2E-06		
Percent of Total		33	3	64		
				Total Cancer Risk	**3E-06**	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	1.9E+02	1E+00	1E+00	NC	2E+00	56
Arsenic	1.3E+01	1E-01	9E-04	NC	1E-01	3
Barium	3.0E+03	1E-01	2E-02	6E-02	2E-01	5
Beryllium	4.0E-01	2E-04	3E-05	NC	2E-04	<1
Cadmium	6.6E+00	2E-02	2E-03	NC	2E-02	<1
Chromium(VI)	2.8E+01	3E-03	3E-04	NC	4E-03	<1
Chromium(III)	1.1E+02	3E-04	6E-05	NC	3E-04	<1
Lead	6.3E+03	NC	NC	NC	NC	NC
Manganese	2.0E+02	3E-03	1E-03	1E+00	1E+00	35
Mercury	4.8E-02	4E-04	2E-05	5E-05	5E-04	<1
Thallium	1.8E+01	5E-02	5E-04	NC	5E-02	1
2,4-Dinitrotoluene	3.5E+00	4E-03	1E-03	NC	6E-03	<1
2,6-Dinitrotoluene	4.6E-01	1E-04	4E-05	NC	1E-04	<1
Pathway Total		1E+00	1E+00	1E+00		
Percent of Total		37	27	36		
				Total Hazard Index:	**4E+00**	
			Blood Lead Concentration µg/dl (95th percentile):		**16.2**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 13-10

SWMU 42 - BOMB WASHOUT BUILDING
CTE CANCER RISK AND HAZARD INDEX FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	1.3E+01	2E-07	1E-09	1E-07	3E-07	31
Beryllium	4.0E-01	2E-08	2E-09	2E-09	2E-08	2
Cadmium	6.6E+00	NC	NC	2E-08	2E-08	2
Chromium(VI)	2.8E+01	NC	NC	6E-07	6E-07	60
2,4-Dinitrotoluene	3.5E+00	2E-08	5E-09	NC	3E-08	3
2,6-Dinitrotoluene	4.6E-01	3E-09	5E-09	NC	8E-09	1
Dioxins/Furans	1.5E-05	2E-08	4E-09	1E-09	3E-08	2
Pathway Total		3E-07	2E-08	8E-07		
Percent of Total		26	2	72		
			Total Cancer Risk		**1E-06**	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	1.9E+02	3E-01	2E-01	NC	5E-01	44
Arsenic	1.3E+01	3E-02	2E-04	NC	3E-02	2
Barium	3.0E+03	3E-02	3E-03	2E-02	5E-02	5
Beryllium	4.0E-01	5E-05	6E-06	NC	6E-05	<1
Cadmium	6.6E+00	4E-03	3E-04	NC	5E-03	<1
Chromium(VI)	2.8E+01	9E-04	5E-05	NC	1E-03	<1
Chromium(III)	1.1E+02	7E-05	1E-05	NC	8E-05	<1
Lead	6.3E+03	NC	NC	NC	NC	NC
Manganese	2.0E+02	9E-04	2E-04	5E-01	5E-01	47
Mercury	4.8E-02	1E-04	4E-06	2E-05	1E-04	<1
Thallium	1.8E+01	1E-02	8E-05	NC	1E-02	1
2,4-Dinitrotoluene	3.5E+00	1E-03	3E-04	NC	1E-03	<1
2,6-Dinitrotoluene	4.6E-01	3E-05	7E-06	NC	4E-05	<1
Pathway Total		4E-01	2E-01	6E-01		
Percent of Total		35	16	49		
			Total Hazard Index:		**1E+00**	
		Blood Lead Concentration μg/dl (50th percentile):			**9.1**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
CTE Central tendency exposure

13.4.2.13. The blood lead estimate of 16.2 µg/dl is indicative of a potential hazard in a small percentage of workers (the 50th percentile blood-lead level was 9.1 µg/dl). All of the statements regarding blood lead levels for the maintenance worker are applicable to the construction worker. In other words, if construction work were to occur in the former wastewater ditch there is a reasonable potential for a hazard to exist; construction outside of the areas with the highest lead concentrations would probably not be associated with adverse effects.

13.4.2.14. The hazard index of 4 has components that both enhance and diminish its significance. The hazard index is driven approximately equally by the inhalation, dermal, and ingestion routes. As discussed under SWMU 1, the ingestion rate is expected to be an overestimate by a factor of 3.5, which would result in an ingestion hazard index of less than one. Other factors, such as the exposure point concentration, would further reduce the potential for adverse effects. This applies to all exposure routes. Dermal exposure is likely overestimated by a factor of four due to the soil adherence factor. The inhalation hazard index is based on the presence of manganese with an exposure point concentration of 200 mg/kg. This concentration is less than the average background concentration for coarse grained soils at Tooele. Consequently, manganese may not represent contamination. It is also likely that with a concentration at SWMU 42 that is less than the average concentration for the western United States (Shacklette and Boeragen, 1984), manganese does not represent an actual hazard. Alternatively, manganese is a hazard to construction workers throughout much of the United States. The CTE evaluation resulted in a hazard index of 1. This evaluation did not account for the biased sampling strategy, and 50 percent of the hazard index is derived from manganese. On the other hand, inhalation reference doses were not available for many COPCs; consequently, the inhalation pathway, has generally not been accounted for in the hazard index. Chromium and copper have exposure doses that are high enough such that the potential for adverse effects is unknown (see the discussion of uncertainties in Section 13.4.3.; Appendix K summarizes the exposure doses).

13.4.2.15. Potential Future TEAD-N Resident. For SWMU 42, the cancer risk from all exposure pathways was estimated to equal 3×10^{-2}, and the hazard index was estimated to equal 200. As shown in Table 13-11, the excess lifetime cancer risk for potential future residents exposed to oil at SWMU 42 was estimated to equal 9×10^{-5}. Most of the calculated cancer risk is from ingestion of arsenic and, to a lesser extent, inhalation of hexavalent chromium in dust, dermal and ingestion exposure to 2,4-DNT, and ingestion of beryllium. The significance of the cancer risk is diminished by the low potential for this pathway to be completed in the future.

TABLE 13-11

SWMU 42 - BOMB WASHOUT BUILDING
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	2.1E+01	6E-05	8E-07	2E-06	1E-04	2E-08	2E-04	<1
Beryllium	5.7E-01	4E-06	1E-06	2E-08	2E-06	1E-09	7E-06	<1
Cadmium	1.2E+01	NC	NC	4E-07	NC	NC	4E-07	<1
Chromium (VI)	2.8E+01	NC	NC	6E-06	NC	NC	6E-06	<1
2,4-Dinitrotoluene	5.6E+00	6E-06	3E-06	NC	2E-02	8E-11	2E-02	89
2,6-Dinitrotoluene	5.9E-01	6E-07	3E-07	NC	3E-03	8E-12	3E-03	10
Dioxins/Furans	1.5E-05	3E-06	2E-06	1E-08	3E-05	1E-07	3E-05	<1
Pathway Total		7E-05	7E-06	8E-06	3E-02	1E-07		
Percent of Total		<1	<1	<1	100	<1		
					Total Cancer Risk:		**3E-02**	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Antimony	3.9E+02	1E+01	8E+00	NC	8E+01	4E-03	1E+02	44
Arsenic	2.1E+01	9E-01	6E-03	NC	1E+00	2E-04	2E+00	<1
Barium	4.7E+03	9E-01	1E-01	1E+00	4E+00	3E-05	7E+00	3
Beryllium	5.7E-01	1E-03	2E-04	NC	5E-04	3E-07	2E-03	<1
Cadmium	1.2E+01	2E-01	1E-02	NC	3E+00	1E-05	3E+00	1
Chromium (VI)	2.8E+01	7E-02	4E-03	NC	2E-02	3E-05	1E-01	<1
Chromium (III)	1.1E+02	1E-03	2E-04	NC	5E-04	5E-07	2E-03	<1
Lead	1.2E+04	NC	NC	NC	NC	NC	NC	NC
Manganese	3.0E+02	3E-02	6E-03	6E-01	2E-01	4E-06	9E-01	<1
Mercury	7.3E-02	3E-03	1E-04	3E-05	1E-02	3E-07	1E-02	<1
Thallium	2.5E+01	4E+00	3E-02	NC	5E-01	3E-02	5E+00	2
2,4-Dinitrotoluene	5.6E+00	4E-02	1E-02	NC	9E+01	4E-07	9E+01	39
2,6-Dinitrotoluene	5.9E-01	8E-03	2E-03	NC	2E+01	7E-08	2E+01	9
Pathway Total		2E+01	9E+00	2E+00	2E+02	3E-02		
Percent of Total		8	4	<1	88	<1		
					Total Hazard Index:		**2E+02**	
			Blood Lead Concentration µg/dl (95th percentile):				**54**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure
TEAD-N Tooele Army Depot North Area

13.4.2.16. The total hazard index for potential future child residents exposed to soil was estimated to equal 30 and the blood lead concentration was estimated to equal 54 µg/dl. The majority of the hazard index is derived from ingestion and dermal exposure to antimony. The actual potential for adverse effects from antimony is uncertain since IRIS cites a low confidence in both the study and the database leading to the reference dose for this metal. The blood lead concentration is in a range where health effects would be expected if the exposure pathway were completed.

13.4.2.17. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 42, the estimated cancer risk is 3×10^{-2} and the hazard index is 200 (Table 13-11), primarily due to the explosives 2,4-DNT, and 2,6-DNT, and antimony. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has several orders of magnitude of uncertainty because of uncertainties in the plant uptake factors (see Section 13.4.3.). If plants metabolize explosives (which is not accounted for in the uptake model), the risks from explosives via this pathway would be low. Because of the high degree of uncertainty, the significant of these risk estimates is unknown.

13.4.2.18. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 42, the estimated cancer risk is 1×10^{-7} and the hazard index is 0.03 (Table 13-11). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 42 if they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

13.4.3. Uncertainties

13.4.3.1. The exposure estimates and toxicity values have associated uncertainties. The magnitude and nature of these uncertainties affect the confidence in the results. Most of the uncertainties are such that risk estimates could be lower, but are unlikely to be higher

than estimated. The following paragraphs discuss uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor. These discussions are focused on elements contributing most to overestimates or underestimates of the total risk. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk.

13.4.3.2. Sampling at SWMU 42 was largely centered on the former wastewater ditch originating at from Building 539 and, consequently, exposure point concentrations are most representative of someone working or otherwise spending time in this ditch. No one works in this ditch at the present time, nor was any sign of recent activity observed. XRF measurements for lead have shown that contamination extends beyond this ditch, but that the ditch is the area where the highest levels of lead are present. However, the XRF data are not of sufficient quality to be used in this risk assessment. Consequently, the exposure point concentrations used in the risk assessment are probably an overestimate for areas where people work, but the magnitude of the overestimate is unknown. The concentrations of 2-nitrotoluene may be an underestimate. 2-Nitrotoluene was not detected in any samples, but analyses were rejected in 17 of the 74 samples analyzed because of low spike recovery. This is expected to have little effect on the risk estimates because 2-nitrotoluene was not detected in any of the other samples.

13.4.3.3. Surface soil samples collected at SWMU 42 were composited from five aliquots evenly distributed on a 5-foot radius. Compositing samples adds uncertainty to the results because the data may not show local hot spots, or may under-represent a hot spot if a highly contaminated sample is blended with samples which are relatively clean. However, a potential hot spot within the 5-foot radius that was sampled would not significantly affect potential risks at the site, because potential receptors would not be exposed only to soil from an area that small for an extended period of time.

13.4.3.4. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having additive toxicities. In addition, the assumption that hazard quotients are additive for

chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

13.4.3.5. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical (tetraethyl lead) with a reference dose below 1 x 10^{-6} mg/kg/day, and this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1 x 10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation of metals with exposure doses greater than 1 x 10^{-6} was examined on a case-by-case basis. The results of this evaluation were presented in Section 13.4.2. Exposure doses are summarized in Appendix K.

13.4.3.6. Maintenance Worker. One factor affecting the cancer risk estimates for the maintenance worker is the assumption that exposure will take place over a 3-year period. This time period was based on the length of time Marines are assigned to work at the vehicle maintenance facility occupying this site. If this portion of the Depot is closed in the future and SWMU 42 became the site of a private industrial operation, the exposure duration could increase.

13.4.3.7. The chemical concentrations in air, which are affected by the dust concentration and the chemical concentration in dust, likely overestimate potential inhalation exposure. The assumed dust concentration was 50 $\mu g/m^3$, which is the National Ambient Air Quality Standard for respirable dust. Air sampling conducted at SWMU 42 (from early October through early December in 1993) gives an insight into the validity of the assumption. TSP concentrations (which include respirable dust and larger particles) were measured using four different samplers. Concentrations were typically between 20 and 55 $\mu g/m^3$, with a low concentration of about 5 $\mu g/m^3$ (measured on a day when it was raining) and a maximum concentration of almost 150 $\mu g/m^3$ (measured on a day when winds were between 20 and 25 miles per hour for several hours). It should be noted that respirable dust concentrations are lower than TSP concentrations (although no correlation has been found that would enable one to estimate respirable dust levels from TSP concentrations), and the air was sampled during late fall, whereas the highest dust

levels would be expected in summer when the soil is driest. These observations indicate that the total dust level of 50 μg/m^3 is not unreasonable, but do not indicate whether the dust is derived from the SWMU.

13.4.3.8. The fraction of dust derived from the SWMU can be examined using the metals data from composites of five samples from each sampler. Lead is a good metal with which to examine this issue because it is so widespread; COPCs covering a smaller area of the SWMU should be subject to greater dispersion in air. The implied soil lead concentration (estimated by dividing the lead concentration in air by the TSP concentration) ranged from about 400 mg/kg to almost 1,700 mg/kg, with most concentrations between 1,000 and 1,300 mg/kg. When this concentration is compared to the soil RME of 12,000 mg/kg, it is evident that either the soil RME is an overestimate of lead concentration in soil, or air samples include dust from outside of SWMU 42, or both, with a net effect of overestimating lead concentrations in air by an order of magnitude.

13.4.3.9. Uncertainties related to ingestion exposure primarily derive from the soil ingestion rate. A typical ingestion rate for adults is probably closer to 25 mg/day (DTSC, 1992), rather than the 50 mg/day assumed in this risk assessment. Dermal exposure uncertainties are associated with the amount of skin covered with soil, and the fraction of contaminant absorbed through the skin. As has been discussed in relation to other SWMUs, the potential for organic compounds to be absorbed more than the assumed 3 percent is indicative that the calculated risk may not be a substantial overestimate.

13.4.3.10. There are also uncertainties associated with the blood lead evaluation. Pregnant female workers could transfer lead to the blood of the fetus. While the anticipated blood-lead level would be slightly lower than in the worker, the fetal blood-lead level of concern would remain 10 μg/dl. The blood-lead model used for adults has not been extensively validated like the child model, so there is greater uncertainty in the predicted adult values.

13.4.3.11. Residents of Grantsville, Stockton, and Depot Housing. One factor affecting inhalation risks for residents of depot housing is the exposure duration. While current residents stay no longer than five years, future residents could stay longer. Other factors leading to the exposure dose estimates are conservative. The dust generation modeling assumed that the soil at SWMU 42 is subject to vehicular or other comparable disturbances once per week, whereas they rarely occur. The air dispersion modeling is designed to assure that concentrations are not underestimated. The inhalation rate of 18

m^3/day used for children is probably an overestimate by a factor of 3 (USEPA, 1995), although the rate of 20 m^3/day may be appropriate for adults. Most people do not live in the same community for 30 years, so the exposure duration for Stockton and Grantsville is likely to be an overestimate.

13.4.3.12. Construction Worker. Uncertainties associated with the exposure dose for a construction worker are high. As discussed in Section 5.0, a reasonable ingestion rate is probably a factor of 3.5 less than the 480 mg/day used in this risk assessment. Also, the bioavailability of the contaminants in the soil is likely to be less than the 100 percent assumed for the BRA, further reducing the actual dose and corresponding risk. The BRA assumed a dust concentration of 1 mg/m^3, which is the upper end of the range of dust levels measured while digging test pits at SWMU 1 (although most of the time dust levels were lower). Air sampling measurements at SWMU 42 support the hypothesis that metal concentrations would probably be an order of magnitude less than estimated, unless a large construction project generated a large amount of dust in addition to that generated by wind.

13.4.3.13. TEAD-N Residents. The uncertainties for construction and maintenance workers are also uncertainties in the evaluation of potential future residents at TEAD-N, although the magnitude of the uncertainties differs. One difference is that in a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure and (to a lesser extent) reduces the potential for dermal and ingestion exposure. As in the case of the construction and maintenance workers, uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the dust level. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who directly eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate exceeds the assumed rate of 200 mg/day. For dermal exposure, young children may cover more of their skin with soil than adults, and the assumed surface area of skin covered with soil is probably more reasonable for this age group than for workers.

13.4.3.14. As discussed in Section 13.2.2., soil samples were also collected beneath ash piles at SWMU 42. Samples were collected from two soil borings. Several metals had elevated concentrations in the surface sample from SB-42-050 (immediately beneath the ash pile) including antimony, barium, cadmium, copper, chromium, lead, silver, zinc, and dioxins and furans. Concentrations at depths of 1 to 2 feet bgs were generally much

lower than in the sample immediately beneath the ash pile. Lead and copper were also found above background concentrations in SB-42-051. Lead is the metal present at the highest concentrations, having been detected at 43,000 mg/kg in one sample, and 4,850 mg/kg in a second sample.

13.4.3.15. The soil beneath the ash piles is being addressed separately as areas of localized contamination. While several of the metals have the potential to cause adverse effects if contacted on a regular basis, no significant current risks are expected because no one works near the piles and the areas are small. There may be a potential for adverse effects (especially from lead, but to a lesser extent from metals such as copper and antinomy) if people come in continual contact with the soil immediately under the ash piles in the future. Because the piles are small, such regular contact and adverse effects are unlikely. This evaluation does not consider the potential effects of the ash itself, as it has not been sampled.

13.4.3.16. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

13.4.3.17. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for metals are expected to have uncertainties on the order of one to two orders of magnitude, based on the factors described above. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2 orders of magnitude, and the regression only had an r^2 value of 0.53.

13.4.3.18. There is even greater uncertainty at SWMU 42. A large fraction of the estimated risks for the produce exposure pathway are from 2,4-DNT and 2,6-DNT. However, the equation used to estimate the plant uptake factors from the log K_{ow} was developed using mostly data for pesticides, which are very different from explosives; a poorer fit would be expected for explosives than for compounds used to develop the

relationship. The plant uptake model also does not account for metabolism of the chemical by the plant. Based on their polar structure, it would not be surprising if plants metabolize 2,4-dinitrotoluene and RDX, thus eliminating exposure to explosives by humans through this pathway. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

13.4.4. Recommendations

13.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Prohibit work outside of Building 539 and the surrounding paved areas unless conducted in accordance with OSHA hazardous waste regulations (29 CFR 1910.120).

- Prohibit construction work unless conducted in compliance with OSHA hazardous waste regulations.

- Evaluate cleanup levels and the appropriate method of corrective action in a Corrective Measures Study.

13.5 ECOLOGICAL RISK ASSESSMENT

13.5.0.1. This section discusses the results of the Tier 1 and Tier 2 ecological evaluations. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors are presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4.

13.5.1. Tier 1

13.5.1.1. Ecological Receptors. The most abundant species at SWMU 42 is rubber rabbitbrush, a native that re-invades disturbed sites. Other species observed at this SWMU include sand dropseed, needle-and-thread grass, Indian ricegrass, red three-awn, matchweed, goatsbeard, annual sunflower, prickly lettuce and gumweed. The asphalt has an occasional kochia and Russian thistle growing between cracks in the surfacing. Big sagebrush, the dominant species in this range site, is conspicuously absent from this location. At other SWMUs, big sagebrush was noted to be re-invading disturbed areas.

It may be that some soil characteristic(s) not visibly apparent (e.g., a caliche layer) favor the dominance of the rubber rabbitbrush. The mapped range and soil type are:

Range Site: Semi-Desert Gravelly Loam
Soil Type: Hiko Peak gravelly loam with 2-15 percent slopes

13.5.1.2. Expected Climax Vegetation. The range site describes the climax vegetation expected to occur at each site due to the combined influence of environmental factors that are characteristic for the site. Expected dominant vegetation includes big sagebrush, Douglas rabbitbrush, Indian ricegrass, bottlebrush squirreltail and Hood phlox.

13.5.1.3. Wildlife. No reptiles were observed at SWMU 42 but, based on sightings elsewhere at the Depot, the collared and side-blotched lizard, the western whiptail, the Great Basin rattlesnake, and the gopher snake may be inhabitants at or near SWMU 42.

13.5.1.4. Indicators of small mammal activity were not as abundant at this SWMU as they were at other locations, with the exception of SWMU 34 (the Pesticide Storage Area). Pellets from black-tailed jackrabbits and cottontail rabbits were observed, as well as valley pocket gopher mounds. Based on observations elsewhere at the Depot and the type of habitat, the common small mammal species that are probable inhabitants at SWMU 37 include the Ord's kangaroo rat, the deer mouse, Great Basin pocket mouse, pinyon mouse, sagebrush vole, the desert woodrat, and the little pocket mouse (Burt and Grossenheider, 1980; RUST, 1994). No large mammals were observed at SWMU 42, but deer pellets were present. Other large mammal species that probably visit SWMU 42 include coyotes and pronghorn antelope.

13.5.1.5. Raptor usage is probably not as varied here due to industrial development and proximity to human activity. The American kestrel, a species adaptable to areas with human activity, is probably the most common raptor. This small falcon feeds on small rodents, lizards and larger insects. Other raptors such as the golden eagle, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, red-tailed hawk, and the great-horned owl may frequent SWMU 42. The great-horned owl is the most common owl in the area, and feeds on a variety of mammals from small rodents to large rabbits and skinks (Craighead, 1976). Because of the typical range of these species during foraging/hunting activities, they may be present at SWMU 42 on an intermittent basis.

13.5.1.6. No passerine or other birds were observed during the site visit. The sage grouse, a State of Utah sensitive species, may inhabit the undisturbed areas of the SWMU. Many other non-game birds such as crows and several families of passerine birds would not be unexpected.

13.5.1.7. Results of the Tier 1 Ecological Assessment. The field surveys indicate that the vegetation at SWMU 42 has been impacted to a greater degree by the physical activities at the site than by the chemicals that may have been released at the site. The vegetation has been disturbed by track vehicles and possibly soil scraping. The ecological assessment is performed with the assumption that the wildlife receptors are not limited by the physical boundaries of each SWMU; therefore, the spatial distribution of the detected chemicals at SWMU 42 is assumed to potentially expose the wildlife species that occur or that may potentially occur at the TEAD-N facility as a whole. The results of the Tier 1 assessment indicate that the detected levels of some of the chemicals at SWMU 42 warrant a Tier 2 evaluation for SWMU 42.

13.5.2. Tier 2

13.5.2.1. The objective of the Tier 2 assessment is to further evaluate the Tier 1 COPECs by comparing the receptor's chemical exposure dose to a biological endpoint.

13.5.2.2. Exposure Analysis. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil. Indirect exposure occurs via the food web, such as when a raptor consumes the mouse. SWMU 42 has no surface water, so the surface water exposure pathway is incomplete and is excluded from the ecological assessment.

13.5.2.3. The reptiles potentially inhabiting SWMU 42 may be exposed via direct pathways (ingestion and dermal exposure to soil) and, to a lesser extent, via food web pathways (e.g., ingestion of contaminated insects). As prey, they may also expose predators.

13.5.2.4. The small mammals are exposed predominantly via direct pathways (ingestion of soil) and, to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators. Antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing) and, as prey, may expose predators. The coyote (a predator) is exposed predominantly via food web pathways.

13.5.2.5. The predominant route of exposure for the raptors is via food web pathways because they typically do not spend much time on the ground. The non-raptor birds are exposed via food web pathways by ingestion of seeds, grasses, and by direct exposure to soil during preening.

13.5.2.6. Risk Characterization. The ecological risk characterization for the COPECs at SWMU 42 was based on the ecological toxicity quotient derived on the dose, via ingestion, to the target species discussed in the methodology. The ingestion pathway is the most significant exposure pathway; therefore, the assessment is based on the worst case scenario. The results of the ecological evaluation are tabulated in Appendix K. The results indicate that antimony, barium, copper, vanadium, thallium, zinc, and lead are the COPECs at SWMU 42 that have ETQs greater than 1.0. The calculations were done with the assumption that the foraging area of the receptors is exclusively within the contaminated area at SWMU 42. This conservative assumption leads to a contaminant intake or dose that is significantly higher than what is actually being ingested by the receptors. However, as noted in the field survey, this SWMU has less animal signs than other SWMUs, and no big sagebrush. The apparent disparity between observations at this and other SWMUs may be the result of exposure to COPECs (most likely lead), some unobserved soil characteristic, or from the past disturbances. It is recommended, therefore, that SWMU 42 be proposed for further investigation based on the ecological assessment.

13.5.2.7. Uncertainties. The evaluation does not take into account the frequency of exposure to the contaminant nor the effect of receptor mobility on the frequency and duration of contact with the contaminated media. The use of NOAEL-type values as surrogates for effective concentration has a significantly more conservative meaning as an indicator of risk.

13.5.3. Recommendations

13.5.3.1. Based on the preceding discussion, it is recommended that the potential for ecological risks at SWMU 42 be further evaluated within the context of a depot-wide risk assessment. This assessment should provide an analysis on the potential for population-scale ecological risks to be present, and indicate whether any mitigating actions are necessary.

13.6 DETERMINATION OF EXPLOSIVE RISK

13.6.1. Potentially Explosive Munitions Items

13.6.1.1. During the field investigation period of October 12, 1993, and May 16-20, 1994, the UXO subcontractor found the following ordnance and ordnance debris in or near SWMU 42, Tooele Army Depot North (TEAD-N):

- 20mm projectiles
- 37mm projectiles
- Cluster Bomb Submunition (Frag/HE)
- Cluster Bomb Submunition (HE/AT)
- Cluster Bomb Submunition (57 mm [shell casings only])
- 105 mm (shell casings only)
- Numerous small arms ammunition

All of the various munition items found during Phase I and Phase II investigations were reported to the Depot OB/OD or Ammunition personnel, who subsequently removed or demilitarized them. In some cases recovered munitions were demilitarized as a precaution whether live or not. Very few actual live items were found.

13.6.2. Risk Interpretation

If the site is to be used in the future a surface UXO survey should be conducted to reduce the risk to foot and vehicle traffic. Prior to any construction or excavation at SWMU 42, a subsurface UXO survey should be conducted to a depth of the excavation plus one foot.

13.6.3. Recommendations

13.6.3.1. Based on the preceding discussions, the following recommendations are made relative to explosive ordnance:

- Restrict access to this area to ordnance personnel employed by TEAD-N

- Provide UXO clearance for any work prior to performing any activity in this area

- Prior to releasing the land for grazing, perform ordnance clearance on 100% of the area to a depth of 12 inches.

14.0 STORMWATER DISCHARGE AREA (SWMU 45)

14.1. SITE BACKGROUND

14.1.0.1. Site Description. The Stormwater Discharge Area is comprised of a small unlined stormwater pond and the associated pipelines that discharge to the pond. The pond, which occupies an area about 10 to 20 feet across, is located midway between the Maintenance and Administration Areas immediately north of a set of railroad tracks. Stormwater from the Administration Area stormwater collection system has been discharged to this area since the Depot was constructed in the early 1940s. Although the pond dries up during the summer months, the presence of phreatophytes in the area indicates saturated soil conditions exist throughout the year. Figure 14-1 shows the location of the discharge pond and the associated stormwater pipelines.

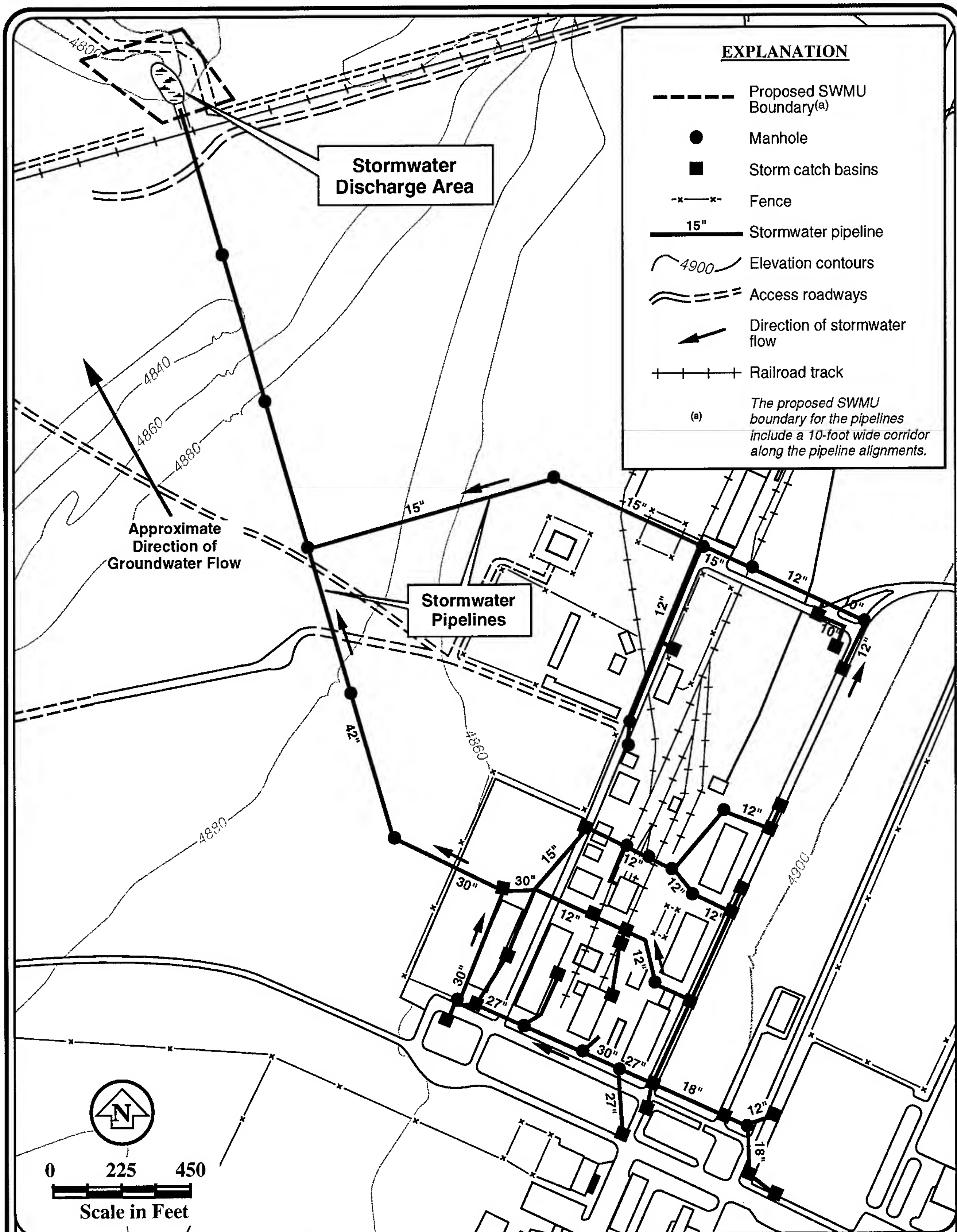
14.1.0.2. Operational Activities. Even though the Stormwater Discharge Area was never the site of any industrial operations, it has received discharges from industrial operations in the nearby Administration Area via the stormwater collection system. Potential sources of contaminants include the Carpenter Shop, Sign Shop, Motor Pool, Rail Shop, and Pesticide Storage Area (SWMU 34), located in the Administrative Area.

14.1.0.3. Geology and Hydrology. Soils in the Stormwater Discharge Area consist of silty and sandy gravels assigned to the Abela Series (USSCS, 1991). Depth of bedrock is unknown; based on information from nearby monitoring wells it is probably greater than 500 feet bgs. Depth to groundwater is approximately 350 feet bgs with flow toward the northwest.

14.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

14.2.1. Previous Investigations

14.2.1.1. Surface water and sediment samples were collected from the discharge pond area in July 1990 by the TEAD Environmental Office. The surface water contained 10 µg/L of methylene chloride, and the sediment sample contained 0.040 mg/kg of



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TEAD-N RFI—GROUP A SWMUs

SWMU 45—STORMWATER DISCHARGE AREA LOCATION MAP

FIGURE 14-1

methylethyl ketone, 0.350 mg/kg of methylisobutyl ketone, and 1.175 mg/kg methylene chloride. Potential sources of these contaminants include the industrial operations in the Administration Area mentioned previously.

14.2.2. RFI Sampling Summary

14.2.2.1. Phase I Sampling. Three surface water samples and five sediment samples were collected from the area where ponded water was present. Surface water samples were analyzed for VOCs, SVOCs, metals (including major cations and cyanide), and explosives. The sediment samples were analyzed for the same constituents as well as pesticides. In addition, to evaluate the potential for vertical contaminant migration, a 25-foot deep soil boring was drilled and sampled as close to the ponded water as possible. Seven samples from the boring were analyzed for VOCs, SVOCs, metals, and explosives.

14.2.2.2. Phase II Sampling. Two new groundwater monitoring wells were installed at SWMU 45 during the Phase II investigation, and two rounds of groundwater samples were collected from these new wells plus one existing well. To assess whether continuous stormwater and wastewater ponding has impacted the local groundwater, the two new monitoring wells (N-142-93 and N-143-93) and an existing well (T-7) were sampled in November 1993 and February 1994. Groundwater samples were analyzed for metals, explosives, VOCs/SVOCs and pesticides.

14.2.2.3. In addition, to address regulatory concerns regarding the condition of the approximately 10,000 feet of stormwater pipeline that discharges to the stormwater pond, the following activities were conducted:

- Approximately 7,000 feet of the stormwater system serving the TEAD-N Administration Area were videotaped using a commercially-available sewer camera system

- Based on the results of the video survey, fourteen 10-foot deep boreholes were drilled and sampled at various locations adjacent to the stormwater lines. Two soil samples from each boring were collected from depths that were immediately beneath the base of the pipeline and from 2 feet to 4 feet below the pipeline base. Soil samples were submitted for analysis of metals, VOCs, SVOCs, pesticides/PCBs, and TPH.

14.2.2.4. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that most of the SWMU 45 data are usable. The USAEC chemistry branch qualified PCB 1260 in five soil samples due to low, high-spike recovery (all results were below the CRL). Sulfate and chloride results were qualified as rejected in three water samples by both chemistry groups due to holding time nonconformances. Additionally, 14 other soil samples were qualified as estimated for inorganic and organic parameters by Montgomery Watson chemists due to MS/MSD nonconformances and blank contamination. Data completeness of 100 percent was achieved for all parameters except sulfate and chloride. The missing data for sulfate and chloride were for water quality assessment purposes and may be obtained during future sampling events. Further details concerning the data review are presented in Appendix E of this document.

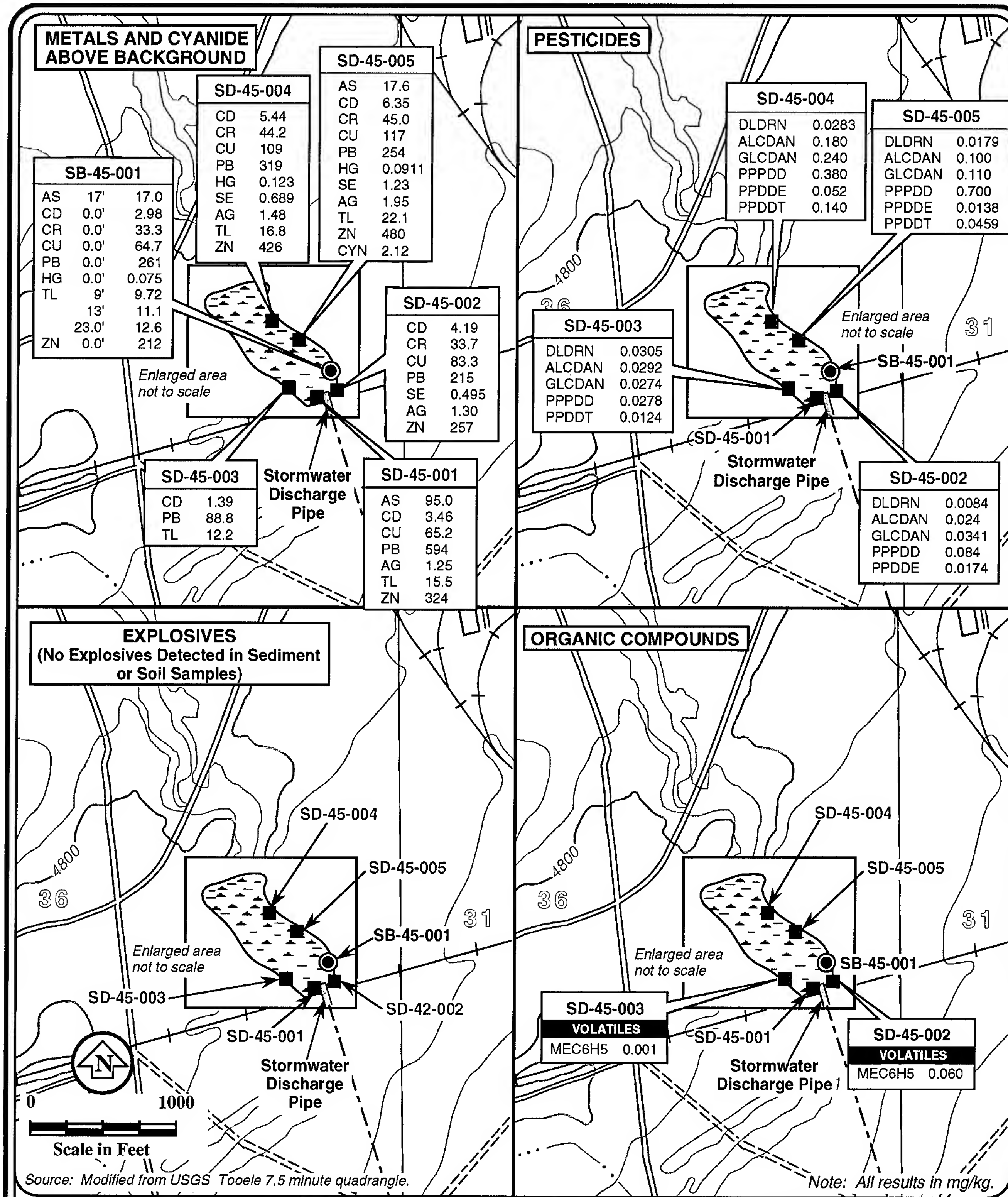
14.2.2.5. The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviation and DQOs were met. Due to this, no data gaps have been identified and additional soil sediment or groundwater sampling is not required to evaluate the need for environmental remediation.

14.3 CONTAMINATION ASSESSMENT

14.3.1. RFI Sampling Results

14.3.1.1. Soil and Sediment-Discharge Area. In soil and sediment, several metals above background levels were detected at the surface including cadmium, chromium, copper, lead, mercury, and zinc (Figure 14-2). Comparison of these results to available risk-based soil guidance thresholds (USEPA, 1994a) shows that all metals results are well below these thresholds for any risk-based scenario. Elevated metals in the subsurface soils in the 25-foot soil boring were limited to arsenic (17 ft bgs) and thallium (9 feet to 23 feet bgs), which were detected at levels just above the background thresholds.

14.3.1.2. Detections of two phthalate compounds from the soil boring, both less than 10 mg/kg, are considered laboratory contaminants, and not included in this contamination assessment as per the methodology noted in Section 3.2.4.4. Because of the common occurrence of phthalate compounds in many common items, it is considered a laboratory or sampling artifact at these low concentrations even in the absence of associated blank contamination. One hexane compound was detected at a deeper interval (23 ft bgs) in the



EXPLANATION

- ■ Sediment sample location
- ◉ Soil boring location
- Railroad tracks
- Approximate alignment of stormwater pipeline
- Access roadway
- 4800 Elevation contour
- Pond area

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TEAD-N RFI—GROUP A SWMUs

STORMWATER DISCHARGE AREA SWMU 45 ANALYTICAL RESULTS FOR SOIL AND SEDIMENT SAMPLES

FIGURE 14-2

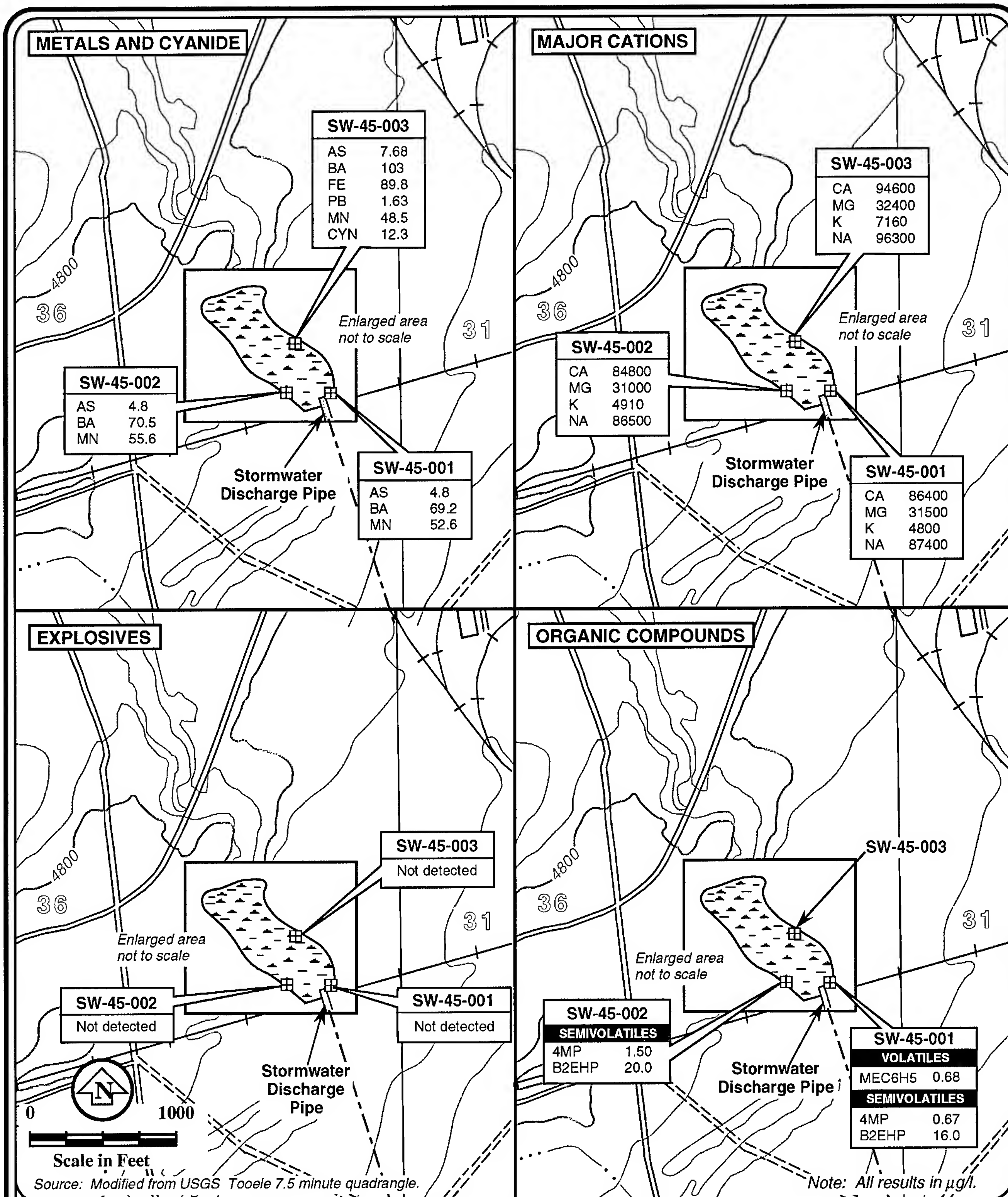
PROJECT NO. 2942.0190

boring as a TIC. No explosive compounds or pesticides were detected in the 25-foot soil boring at the discharge pond.

14.3.1.3. Sediments. In the sediments, elevated concentrations of numerous metals were present when compared to the background thresholds for soils. In addition, detectable concentrations of numerous pesticides, including DDT and degradation products of pesticides were present. Detections of volatile organics and semi-volatile organics were limited to two low concentrations of toluene. No explosives were detected in the sediment samples. Figure 14-2 shows the analytical results for soil and sediment samples collected at the discharge pond.

14.3.1.4. Surface Water. Analytes detected in the three surface water samples collected from the discharge pond include several metals, cyanide, toluene, and two SVOCs. No explosives were detected. With one exception, none of these analytes exceeded established MCLs or available risk-based guidance thresholds. Bis (2-ethylhexyl) phthalate was detected in two of the surface water samples at levels above the available risk-based guidance threshold for this compound for tap water (5.7 μg/L). Figure 14-3 presents the analytical results for the surface water sampling at the discharge pond.

14.3.1.5. Video Camera Survey (Stormwater Lines). The video survey found that the stormwater pipelines in the Building 500 Area were in good condition and, with several exceptions, free of sediment and debris that could impede water flow. The video survey was used to locate several of the soil borings sampled for soil contamination associated with leakage. During the video camera survey, concrete stormwater lines ranging in size from 8 inches to 42 inches in diameter were videotaped. Very little major line damage was seen. Two pipe offsets were seen in the line section running along the east side of the main Administration Area road, which appeared to have been damaged during construction of more recent water lines. Several other line sections showed evidence of weathered joints and minor cracks along the tops and bottoms of the pipes. Several short sections of the system contained standing water. One 30-inch diameter section located immediately west of the Motor Pool, contained hydrocarbons (i.e., waste oil, gasoline, solvents, or a mixture) with the standing water. These constituents were detectable by aroma and FID, and were also visible to the camera operator.



EXPLANATION

- ⊞ Surface water sample location
- ◉ Soil boring location
- Railroad tracks
- Approximate alignment of stormwater pipeline
- Access roadway
- 4800 Elevation contour
- Pond area

MONTGOMERY WATSON

TEAD-N RFI—GROUP A SWMUs
STORMWATER DISCHARGE AREA
SWMU 45
ANALYTICAL RESULTS FOR SURFACE WATER
FIGURE 14-3

PROJECT NO. 2942.0190

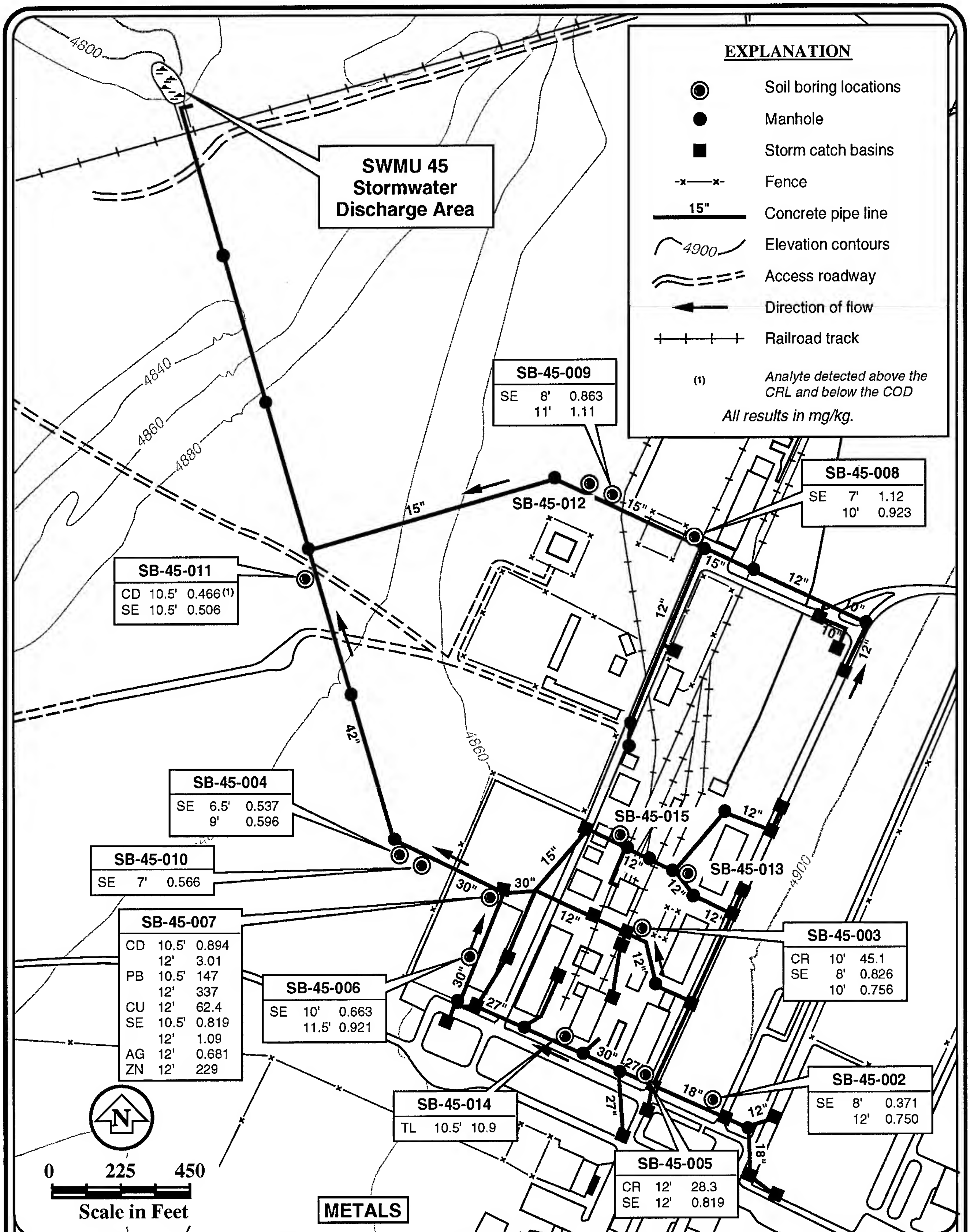
14.3.1.6. Subsurface Soils - Building 500 Area (Stormwater Lines). Elevated concentrations of metals were detected in 10 of the 15 soil borings completed during the shallow soil boring program. In five of these, selenium was the only metal detected above background, and these detections were low compared to the background threshold for this metal. The frequency and uniformity of these detections could be an indication of naturally-occurring background conditions in the subsurface soils. Other metals detected in shallow soils along the stormwater line included thallium, cadmium, lead, copper, silver, zinc, and chromium. Except for lead, all detections were low compared to the respective background thresholds and available risk-based soil guidance thresholds (USEPA, 1994a). Lead was detected at a concentration of 337 mg/kg in boring SB-45-007 at a depth of 12 feet bgs, which is significantly higher than the RFI background threshold for lead in coarse-grained soils at TEAD-N. Figure 14-4 shows the metals results for the stormwater line investigation.

14.3.1.7. The shallow soil boring program along the Building 500 Area stormwater lines also detected several concentrations of the PAHs pyrene and phenanthrene, as well as two phthalate compounds and two pesticides. The concentrations of all these organic compounds were low when compared with suggested risk-based guidance thresholds (USEPA, 1994a), where available. Figure 14-5 presents the results for organic compounds detected during the stormwater line investigation.

14.3.1.8. Groundwater. Figures 14-6 and 14-7 show the results of the groundwater sampling conducted at SWMU 45 in November, 1993 and February, 1994, respectively. Comparison of the metals results to available drinking water MCLs and risk-based guidance thresholds for tap water (USEPA, 1994a) shows that none of the detected metal constituents exceeded their MCLs, and only arsenic exceeded the risk-based threshold. Note that because of normal sampling and analytical variability the arsenic concentrations of 2.77 to 4.80 detected in the February 1994 sampling round are not appreciably different from the non-detect results in the November, 1993 sampling round, where the detection limit was 2.54 μg/l.

14.3.1.9. Statistical analyses were also performed to determine background arsenic concentrations in groundwater at SWMU 45. Data from monitoring wells N-111-88, N-112-88, N-114-88 through N-117-88, N-140-93, N-141-93, N-142-93, and water well WW-1 (considered background wells) were used to calculate the upper tolerance limit for arsenic. The tolerance limit was determined using the lowest detection of arsenic collected from each of these wells and calculated using the method specified in EPA guidance documents (USEPA, 1989a) according to the formula;

$$TL = \bar{x} + KS$$



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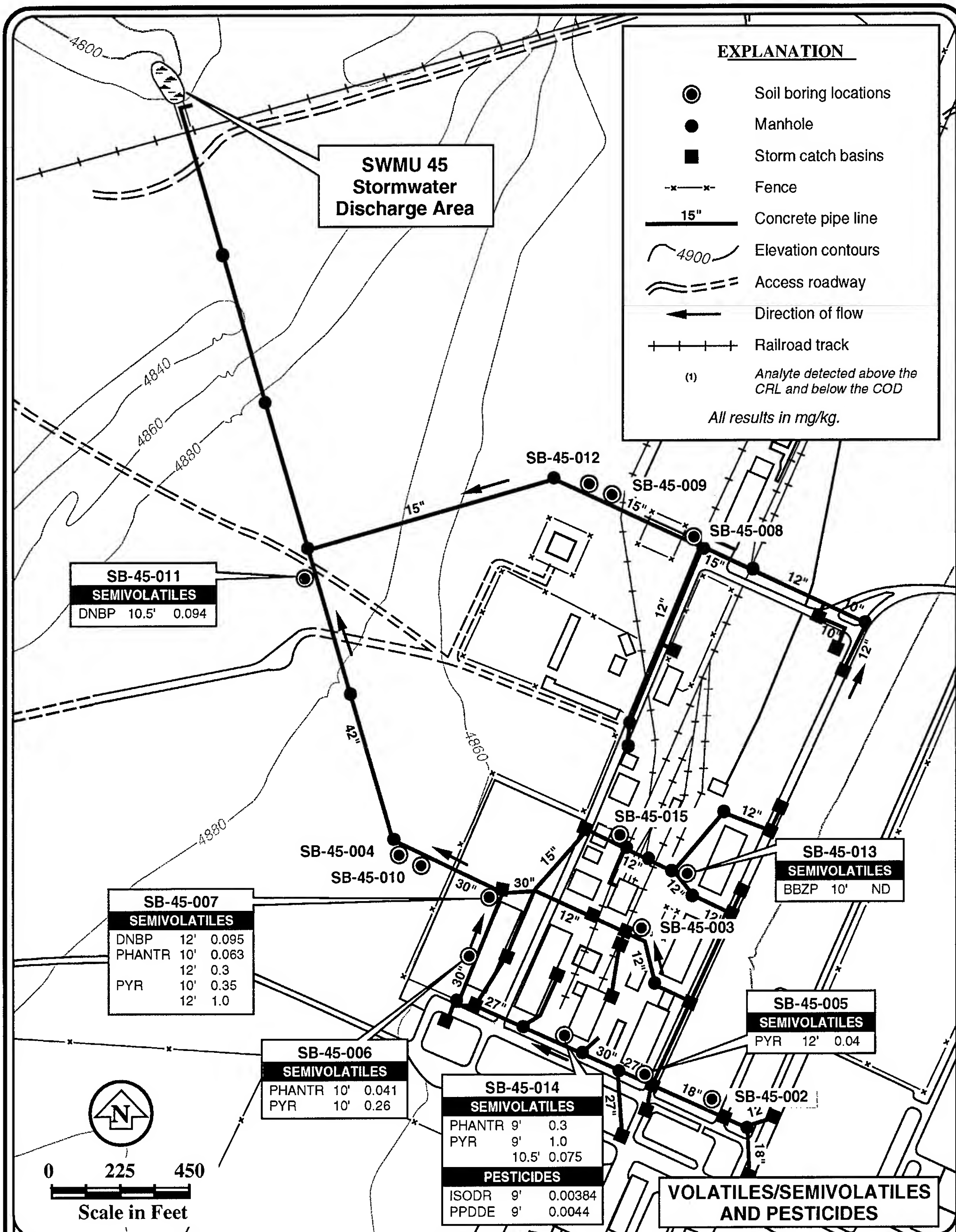
TEAD-N RFI—GROUP A SWMUs
SWMU 45–500-SERIES BUILDINGS
STORMWATER LINE INVESTIGATION
ANALYTICAL RESULTS FOR SHALLOW SOILS
FIGURE 14-4



TEAD-N RFI—GROUP A SWMUs

SWMU 45–500-SERIES BUILDINGS
STORMWATER LINE INVESTIGATION
ANALYTICAL RESULTS FOR SHALLOW SOILS

FIGURE 14-5

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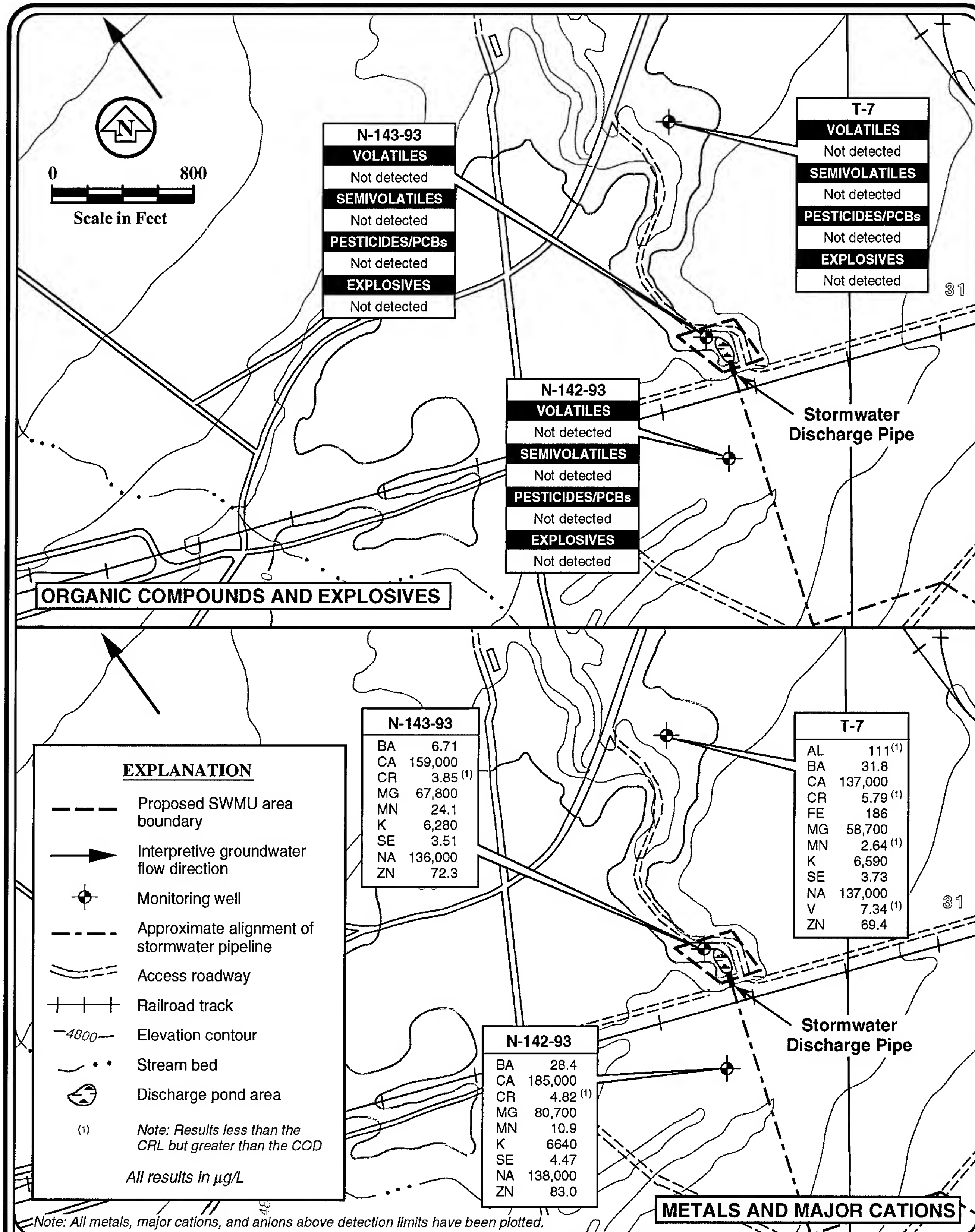

Source: *Modified from USGS Tooele 7.5 minute quadrangle.*

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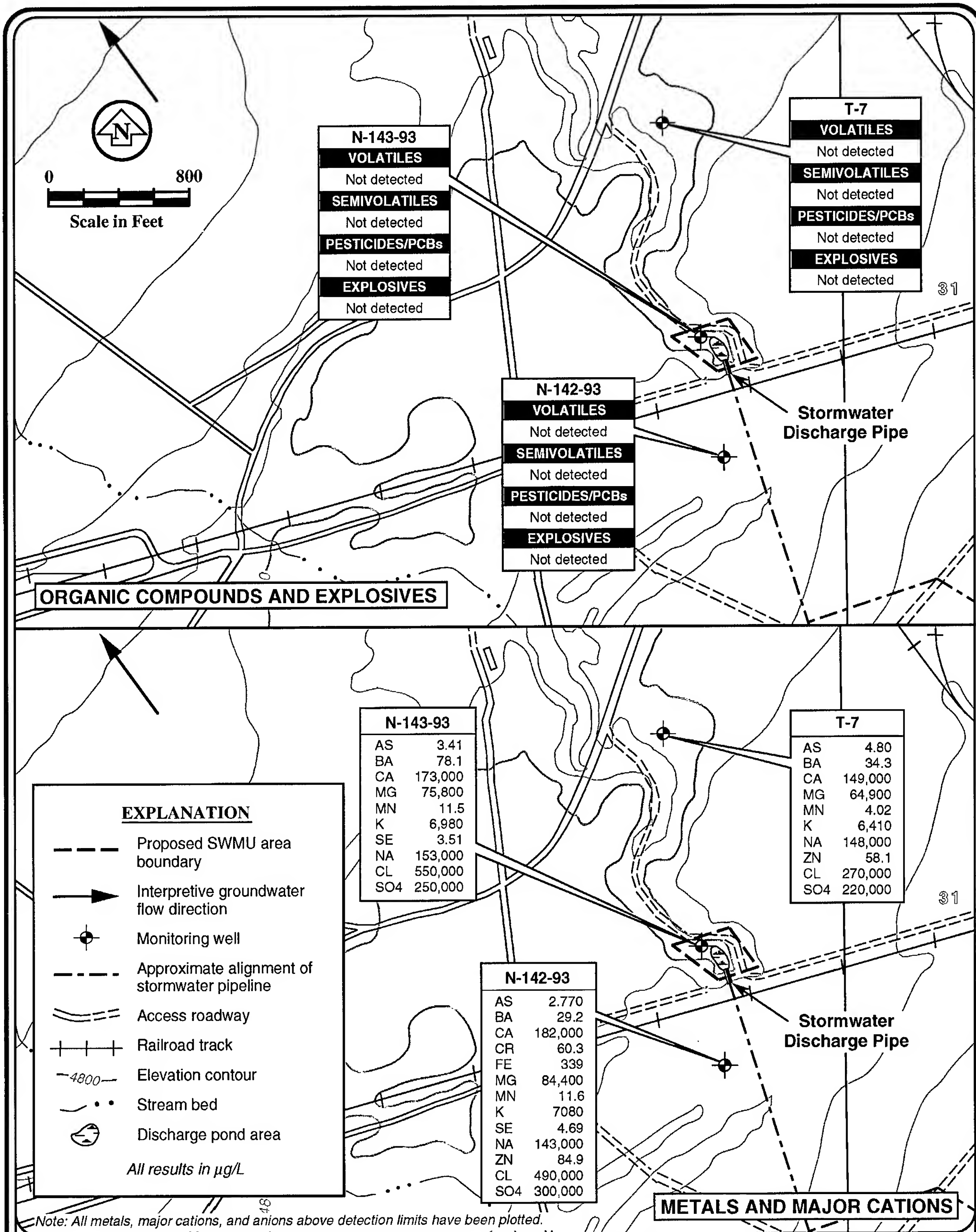
TEAD-N RFI—GROUP A SWMUs
SWMU 45
STORMWATER DISCHARGE AREA
ANALYTICAL RESULTS FOR GROUNDWATER
NOVEMBER 1993
FIGURE 14-6

PROJECT NO. 2942.0190



Source: Modified from USGS Tooele 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 45
STORMWATER DISCHARGE AREA
ANALYTICAL RESULTS FOR GROUNDWATER
FEBRUARY 1994
FIGURE 14-7

PROJECT NO. 2942.0190

where TL is the tolerance limit, $\bar{x}$ is the mean of the population, S is the standard deviation and K is the one-side normal tolerance factor. The results of this statistical determination show that the arsenic tolerance limit is 10.4 µg/l, and therefore arsenic detected in the downgradient wells (N-143-93 and T-7) at SWMU 45 is within the limits of natural background conditions and are not attributable to site contamination. Because arsenic is at background concentrations, it has not been included as part of the risk assessment.

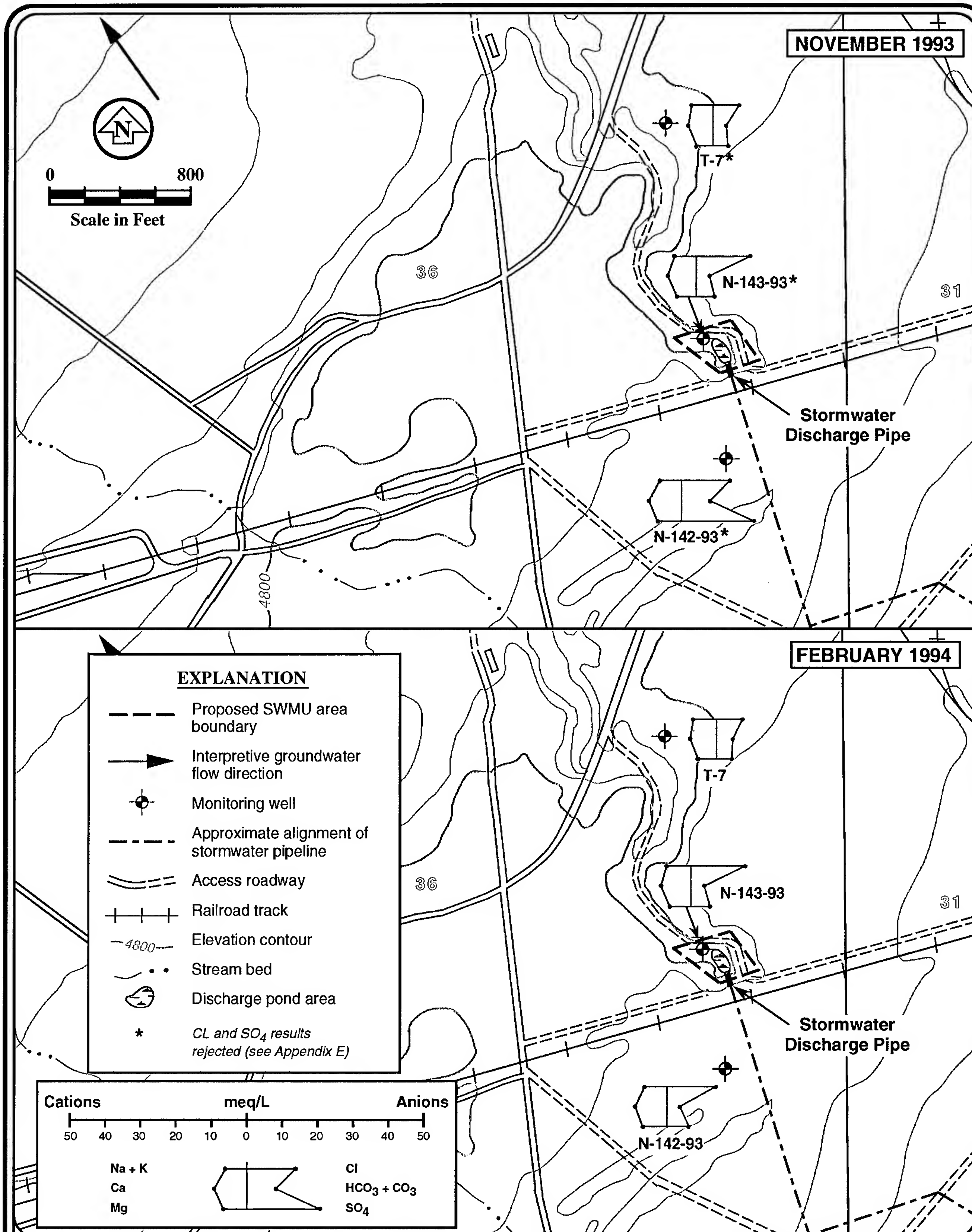
14.3.1.10. The VOC chloroform was detected in the duplicate sample from well N-142-93 during the February sampling round, but is considered not detected due to its presence in an associated method blank and will not be included as part of the contamination assessment (see Section E.4.1 in Appendix E). No other VOCs, SVOCs, pesticides, or explosives were detected in any of the wells during either round of sampling.

14.3.1.11. Figure 14-8 presents groundwater quality data from the sampling at SWMU 45 graphically by means of Stiff diagrams for each well.

14.3.2. Nature and Extent of Contamination

14.3.2.1. Sampling activities, previous to and including the RFI, show that various contaminants have been released to the stormwater discharge ponding area at SWMU 45. These contaminants probably originated from one or more industrial activities in the Administration Area and were transported via the concrete stormwater lines which discharge into this ponding area. Even though elevated metals, VOCs/SVOCs, and pesticide compounds were found to be present in the sediment and/or surface water at the discharge pond, these analytes do not appear to have migrated vertically below the pond based on results of the adjacent 25-foot soil boring. Local groundwater has not been impacted by the discharge pond; no organic compounds were present and metals and cations were detected in the same range in both upgradient and downgradient wells.

14.3.2.2. Shallow soil sampling along the stormwater lines show that, with some exceptions, these lines have not released contaminants to the adjacent soils. The sampling program confirmed the conclusion of the prior video survey; i.e., the stormwater system draining the Building 500-Series Area is in generally good repair.



Source: Modified from USGS Tooele 7.5 minute quadrangle.

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TEAD-N RFI—GROUP A SWMUs
SWMU 45
STORMWATER DISCHARGE AREA
STIFF DIAGRAMS
NOVEMBER 1993—FEBRUARY 1994
FIGURE 14-8

PROJECT NO. 2942.0190

14.3.3. Selection of COPCs and COPECs

14.3.3.1. Identification of COPCs. The selection of the COPCs for the Stormwater Discharge Area (SWMU 45) was based on the screening procedures outlined in Section 3.2.6. A summary of all chemicals detected in samples from SWMU 45, their maximum concentrations, their frequency of detection, the analytes selected as COPCs, and the rationale for the analytes not selected as COPCs is shown in Table 14-1. Because chromium is not known to have been used in this area as CrVI, all chromium was assumed to be in the trivalent state.

14.3.3.2. Chemicals of potential concern for human health in soil at SWMU 45 include the metals cadmium, chromium, lead, mercury, and silver. No organic chemicals were detected in the soil. Chemicals of concern in sediment include the metals arsenic, cadmium, chromium, lead, mercury, thallium, and vanadium. The organic chemicals were not present in concentrations high enough to be selected as COPCs.

14.3.3.3. Chemicals of potential concern for surface water included all chemicals detected, which were the inorganics arsenic, barium, cyanide, manganese, and lead, and the organics bis(2-ethylhexyl)phthalate, 4-methylphenol, and toluene. Chemicals of potential concern in groundwater at SWMU 45 include the metals barium, chromium, manganese, selenium, vanadium, and zinc. As discussed earlier in this section, an analysis was performed on background wells through TEAD-N, and arsenic concentrations detected in SWMU 45 groundwater do not represent elevated concentrations. No indication of groundwater contamination was found at SWMU 45, and the concentrations of other metal COPCs may also be present at background concentrations, but a quantitative analysis has not been performed. The concentration of analytes detected in the two downgradient wells were similar to the upgradient well and no other indicators of contamination such as the presence of organic chemicals or anomalously high concentrations of inorganic chemicals were observed. All analytes except arsenic detected in the two downgradient wells with toxicity values in IRIS or HEAST were retained as COPCs.

14.3.3.4. Identification of COPECs. The COPECs were selected based on the criteria outlined in the methodology discussion (Section 3.2.7.). The COPECs that are evaluated in Tier 2 and the reason for the exclusion of analytes from further evaluation are presented in Table 14-1. The only soil COPEC at SWMU 45 is lead and the sediment COPECs include arsenic, cadmium, lead, thallium, vanadium, and p,p-DDT. The

TABLE 14-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN
FOR ANALYTES DETECTED IN SOIL, SEDIMENT, GROUNDWATER, AND SURFACE WATER
AT SWMU 45–STORMWATER DISCHARGE AREA

Chemical	Maximum Concentration (mg/kg)	Frequency of Detection (percent)	Evaluated in Risk Assessment: Human	Evaluated in Risk Assessment: Ecological
SOIL				
Aluminum	9.7E+03	100	No (a)	No (a)
Arsenic	1.3E+01	100	No (a)	No (a)
Barium	1.1E+02	100	No (a)	No (a)
Beryllium	6.3E-01	25	No (a)	No (a)
Cadmium	**3.0E+00**	**25**	**Yes**	No (e)
Chromium	**3.3E+01**	**100**	**Yes**	No (e)
Cobalt	4.2E+00	100	No (a)	No (a)
Copper	6.4E+01	100	No (b)	No (e)
Lead	**2.6E+02**	**100**	**Yes**	**Yes**
Manganese	4.5E+02	100	No (a)	No (a)
Mercury	**7.5E-02**	**25**	**Yes**	No (e)
Nickel	1.0E+01	100	No (a)	No (a)
Silver	**7.1E-01**	**25**	**Yes**	No (e)
Thallium	8.1E+00	25	No (a)	No (a)
Vanadium	2.0E+01	100	No (a)	No (a)
Zinc	2.1E+02	100	No (b)	No (e)
SEDIMENT				
Aluminum	1.4E+04	100	No (a)	No (a)
Arsenic	**9.5E+01**	**100**	**Yes**	**Yes**
Barium	2.1E+02	100	No (a)	No (a)
Beryllium	1.1E+00	60	No (a)	No (a)
Cadmium	**6.4E+00**	**100**	**Yes**	**Yes**
Chromium	**4.5E+01**	**100**	**Yes**	No (e)
Cobalt	7.9E+00	80	No (d)	No (e)
Copper	1.1E+02	100	No (b)	No (e)
Cyanide	2.1E+00	20	No (c)	No (e)
Lead	**5.9E+02**	**100**	**Yes**	**Yes**
Manganese	5.4E+02	100	No (a)	No (a)
Mercury	**1.2E-01**	**40**	**Yes**	No (e)
Nickel	2.2E+01	100	No (c)	No (e)
Selenium	1.2E+00	60	No (c)	No (e)
Silver	1.9E+00	80	No (c)	No (e)
Thallium	**2.2E+01**	**80**	**Yes**	**Yes**
Vanadium	**3.3E+01**	**100**	**Yes**	**Yes**
Zinc	4.8E+02	100	No (c)	No (e)
Dieldrin	2.8E-02	80	No (c)	No (e)
p,p-DDD	7.0E-01	80	No (c)	No (e)
p,p-DDE	5.2E-02	60	No (c)	No (e)
p,p-DDT	1.4E-01	60	No (c)	**Yes**
Toluene	6.0E-02	40	No (c)	No (e)

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium
Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

(a) Analyte was detected at or below background concentrations
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte contributed less than 1 percent in a concentration - toxicity screen
(d) Low toxicity metal with inadequate toxicity data
(e) Maximum concentration less than NOAEL or estimate of NOAEL
(f) Ecological risks not evaluated for groundwater

TABLE 14-1

TEAD-N BASELINE RISK ASSESSMENT SCREEN FOR ANALYTES DETECTED IN SOIL, SEDIMENT, GROUNDWATER, AND SURFACE WATER AT SWMU 45–STORMWATER DISCHARGE AREA (CONTINUED)

Chemical	Maximum Concentration (µg/l)	Frequency of Detection (percent)	Evaluated in Risk Assessment	
			Human	Ecological
GROUNDWATER				
Aluminum	1.1E+02	25	No(d)	No(f)
Arsenic	4.8E+00	50	No(a)	No(f)
Barium	**7.8E+01**	**100**	**Yes**	No(f)
Chromium	**5.8E+00**	**50**	**Yes**	No(f)
Manganese	**2.4E+01**	**100**	**Yes**	No(f)
Selenium	**3.7E+00**	**75**	**Yes**	No(f)
Vanadium	**7.3E+00**	**25**	**Yes**	No(f)
Zinc	**7.2E+01**	**75**	**Yes**	No(f)
SURFACE WATER				
Arsenic	**7.7E+00**	**100**	**Yes**	**Yes**
Barium	**1.0E+02**	**100**	**Yes**	**Yes**
Cyanide	**1.2E+01**	**33**	**Yes**	**Yes**
Manganese	**5.6E+01**	**100**	**Yes**	**Yes**
Lead	**1.6E+00**	**33**	**Yes**	**Yes**
Bis(2-ethylhexyl)phthalate	**2.0E+01**	**67**	**Yes**	**Yes**
4-Methylphenol	**1.5E+00**	**67**	**Yes**	**Yes**
Toluene	**6.8E–01**	**33**	**Yes**	**Yes**

Analytes detected but not shown include calcium, iron, magnesium, potassium, and sodium
Chemicals of potential concern for evaluation in the human health risk assessment are depicted with their chemical name in bold print.

(a) Analyte was detected at or below background concentrations
(b) Analyte is an essential nutrient (see Section 3.2.6.)
(c) Analyte contributed less than 1 percent in a concentration - toxicity screen
(d) Low toxicity metal with inadequate toxicity data
(e) Maximum concentration less than NOAEL or estimate of NOAEL
(f) Ecological risks not evaluated for groundwater

COPECs in the surface water are arsenic, barium, cyanide, manganese, lead, bis(2-ethylhexyl)phthalate, 4-methylphenol, and toluene.

14.3.4. Contaminant Fate and Transport

14.3.4.1. As discussed in the preceding section, the contaminants of concern at SWMU 45 include metals, SVOCs, and VOCs (Table 14-1). Table 3-4 briefly describes the fate and transport characteristics for the contaminants of potential concern identified in Table 14-1. The remainder of this section will present a conceptual model of contaminant fate and transport at SWMU 45 and discusses the fate and transport of the contaminants of concern.

14.3.4.2. Conceptual Model. A conceptual site model of contaminant transport has been developed (Figure 14-9) based on the physical site characteristics presented in Section 2.0 and the contamination assessment presented above. This model displays the potential routes of contaminant migration from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear to be unlikely based on currently available data. Contamination at SWMU 45 has been released to the surface water, sediment and soil as discharge water at the stormwater pipeline out-fall as well as to subsurface soils from leaks in the pipeline at several locations along its length. The surface and shallow soils at SWMU 45 consist of gravely sand, silty sand, and sandy and silty gravel. The ground water is approximately 350 feet bgs at the stormwater line out-fall.

14.3.4.3. Fate and Transport of Metals. Because the discharge pond contains water, and because fluids move through leaks in the stormwater pipeline, a potential driving mechanism for contaminant transport exists at SWMU 45. However, the sampling of deep soils and groundwater beneath the discharge pond, indicate that no organic compounds or elevated metals were detected below the surface. The metals detected in groundwater beneath the site were detected in both the upgradient and downgradient wells and likely are naturally occurring. Elevated concentrations of arsenic and thallium were detected in soils beneath the discharge pond, but their concentrations were only slightly above background, can be attributed to natural variations in the subsurface, and likely do not represent an anthropogenic source. Based on the current conditions at SWMU 45, the relatively low metals concentrations, and alkaline soil conditions it is not

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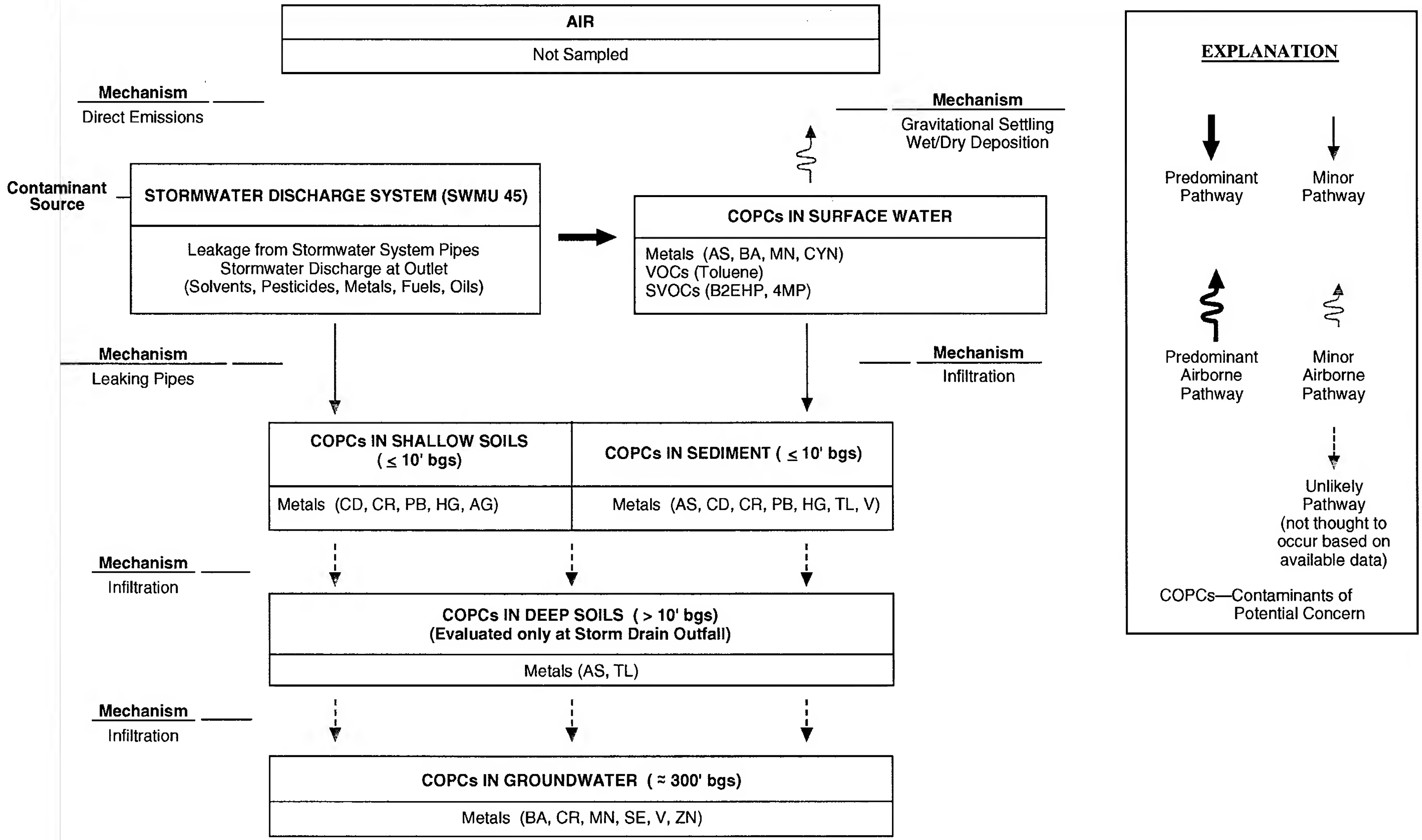

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TEAD-N RFI—GROUP A SWMUs
STORMWATER DISCHARGE SYSTEM—SWMU 45
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 14-9

expected that the metals would be transported to groundwater. Downstream migration of metal contaminants via surface-water drainage may be a transport pathway.

14.3.4.4. Fate and Transport of SVOCs. Table 3-4 briefly describes the fate and transport characteristics of SVOCs. The SVOC bis(2-ethylhexyl)phthalate will strongly adsorb to soils and will resist leaching to deeper soil horizons and to the groundwater. This compound will only moderately adsorb to the sediment in the discharge pond, and concentrations in the discharge pond waters are expected to attenuate by hydrolysis and photolysis. Bis(2-ethylhexyl)phthalate will volatilize very slowly from surface soil and sediment, so this is not likely to be a significant fate process. It is expected to slowly attenuate by biodegradation processes, however. This phthalate may also adsorb to particulates and be transported via the air pathway where they may photodegrade or oxidize and be removed by wet/dry deposition.

14.3.4.5. Fate and Transport of VOCs. Table 3-4 briefly describes the fate and transport characteristics of VOCs. Toluene is highly volatile in shallow soil. This compound does not significantly adsorb to sediment and is low to moderately soluble in water. Toluene also volatilizes readily from surface water. Toluene is also readily biodegradable in soil and water.

14.4 HUMAN HEALTH RISK ASSESSMENT

14.4.0.1. The methods used to estimate the risks associated with SWMU 45 are given in the Human Health Risk Assessment Methodology, Section 3.2.6. The COPCs were identified in the previous section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 45) is presented in the following sections.

14.4.1. Exposure Pathways and Receptors

14.4.1.1. The pathways quantitatively evaluated in the BRA are: 1) those that are complete or likely to be completed in the future, and 2) those that may potentially cause a significant risk. An evaluation of completeness is shown on Figure 14-10, which is a diagram of potential exposure pathways for SWMU 45. An evaluation of pathway completeness and an assessment of whether a pathway is significant enough to require further evaluation for current and potential future receptors at SWMU 45 is given in Tables 14-2 and 14-3, respectively.

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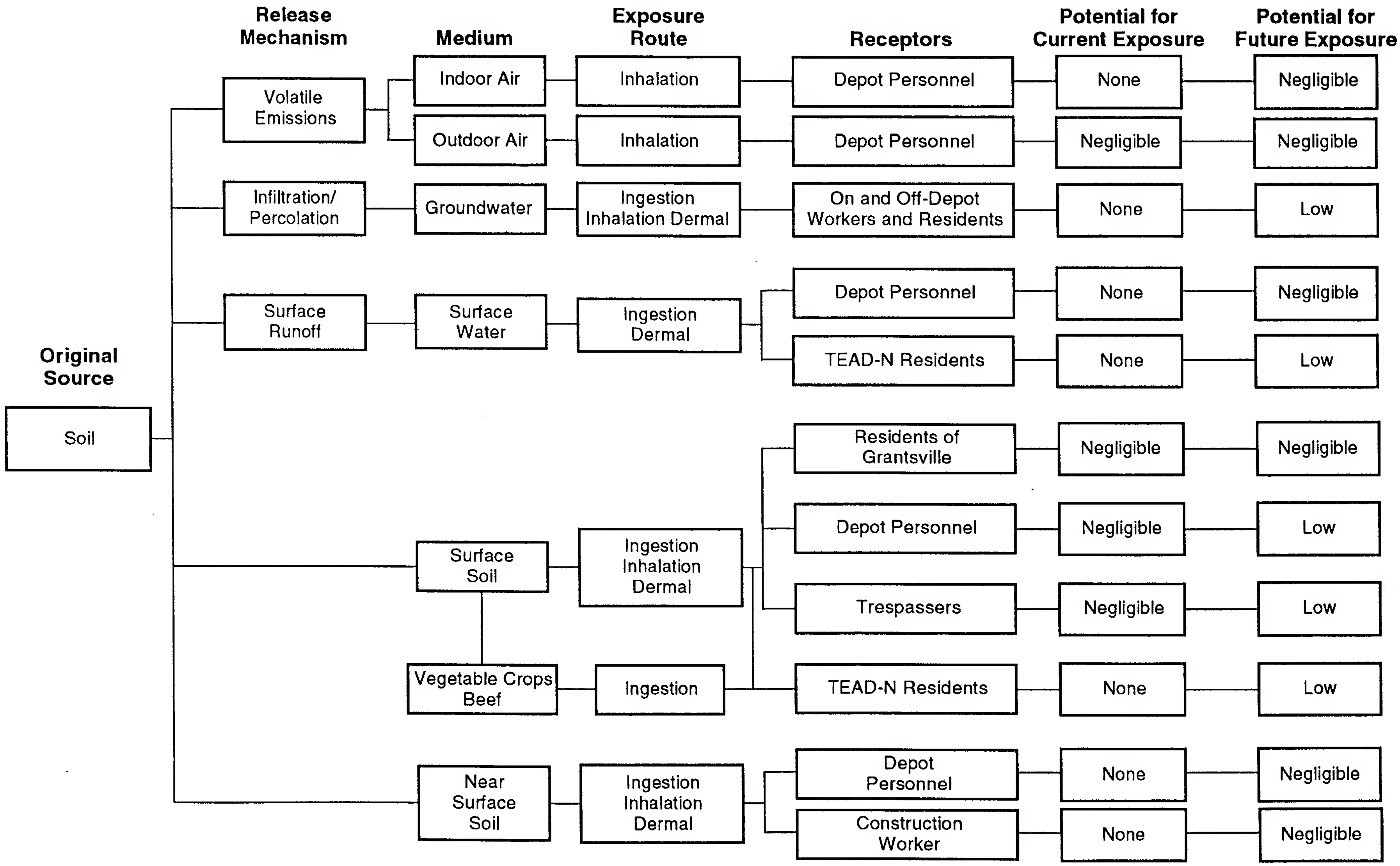

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TEAD-N RFI—GROUP A SWMUs
STORMWATER DISCHARGE AREA—SWMU 45
EXPOSURE PATHWAYS DIAGRAM
FIGURE 14-10

TABLE 14-2

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 45: STORMWATER DISCHARGE AREA

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater is estimated to be 350 feet below ground surface and is not known to be contaminated.
Surface Water and Sediment	Depot Personnel	Incidental ingestion and dermal contact with water or sediment	Yes. Depot personnel were evaluated to provide a benchmark, even though Depot personnel activity patterns do not include the stormwater discharge area, there are no buildings within 2,000 feet, and there is no evidence of human activity.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. Pond area is small and is located in a topographic depression providing some shelter from the wind. The presence of phreatophytes further decreases the wind erosion potential and is an indication of moist soil.
	Depot Personnel	Incidental ingestion of dust, inhalation, and dermal contact	Yes, for inhalation only. Depot personnel were evaluated to provide a benchmark, even though depot personnel activity patterns do not include the stormwater discharge area, there are no buildings within 2,000 feet, and there is no evidence of human activity.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers have not been observed at this area.
Near-Surface Soil	Depot Personnel	Incidental ingestion of dust, inhalation, and dermal contact	No. Near-surface soil is contaminated but the activity patterns of Depot personnel do not include the stormwater discharge area.
Air	Depot Personnel	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and the current activities of Depot personnel do not include the stormwater discharge area. Dust exposure evaluated under soil.

TABLE 14-3

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 45: STORMWATER DISCHARGE AREA

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	Yes, for ingestion only. While this SWMU is not within the existing closure parcel, the groundwater could be used if this area of the Depot were closed in the future. Dermal exposure will not be evaluated because the COPCs are metals, and they have low dermal permeabilities.
Surface Water and Sediment	Future TEAD-N residents	Incidental ingestion, dermal contact with water or sediment	Yes. While this SWMU is not within the existing closure parcel, residential development would be possible if this area of the Depot were closed in the future. Surface water and sediment are contaminated, and the area would be attractive to children.
		Ingestion of beef from cattle drinking surface water at this SWMU.	Yes. Cattle could take up contaminants from surface water.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. Area is in a depression and the soil is moist, so dust is minimal.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. While this SWMU is not within the existing closure parcel, residential development would be possible if this area of the Depot was closed in the future. Surface soil is contaminated.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Depot personnel	Incidental ingestion of dust, inhalation, and dermal contact	No. Exposure will be the same as that evaluated under current conditions.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers are not anticipated and exposure would be less than for a residential scenario.
Near-Surface Soil	Construction worker	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Although excavations or structures are unlikely in this area because it is a depression, this pathway is evaluated.
Air	Future TEAD-N residents	Inhalation of volatile organics from subsurface soil	No. The concentration of volatile organics is less than 1 mg/kg and therefore only a minimal potential for exposure exists. Dust exposure evaluated under soil.

14.4.1.2. The Stormwater Discharge Area (SWMU 45) has no current receptors. SWMU 45 is located in a remote portion of the Depot, approximately one-half mile from the nearest building. Depot personnel activities do not involve SWMU 45, and the remoteness of this SWMU makes incidental exposure unlikely. However, to provide a benchmark for the COPCs in the surface water and sediment, a Depot worker was assumed to trespass once per month for the six warm weather months. The activities were assumed to be wading in the discharge pond, an unlikely scenario.

14.4.1.3. In the future, construction workers could become receptors for contaminants originating at SWMU 45. However, if construction work were to occur in this area, it would likely occur nearby, instead of within the SWMU because of the topographic depression and the fact that the area would need to be dewatered. If housing were built near SWMU 45, the stormwater discharge would likely be reverted and the sediment would become soil. As shown in the exposure pathway diagram (Figure 14-10), construction workers can be exposed to contaminants in the soil by ingestion, dermal contact, and inhalation of dust. For future construction workers, direct exposure results from the anticipated excavation activities associated with construction, and includes subsurface soil as well as surface soil. Because of the remoteness of this SWMU, future development of this area by the Depot is not foreseen. Although future scenarios involving construction workers are unlikely, this scenario has been evaluated to provide a benchmark for contaminants in near-surface soil.

14.4.1.4. Should this portion of the Depot be closed in the future, residents could become receptors. If housing was built in this area, it would likely be built nearby, instead of within the SWMU because of the topographic depression and the fact that the area would need to be dewatered. However, if housing were built near SWMU 45, the stormwater discharge would likely be reverted. There would not be exposure to surface water, but sediment would become surface soil. The residential scenario was evaluated to provide a benchmark for evaluating the COPCs present in the soil, sediment, and groundwater. The potential future residents at TEAD-N were presumed to be exposed to contaminants in the soil and sediment by ingestion, dermal contact, and inhalation of dust, and to groundwater by ingestion. Because the COPCs in groundwater are metals, inhalation of COPCs while showering is not a complete pathway. While the dermal pathway would be complete, metals are poorly absorbed through the skin (USEPA, 1992), and dermal exposure is much less than by ingestion.

14.4.1.5. SWMU 45 could be converted into an area where crops are grown and future residents could eat the fruits and vegetables that are grown. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. The cattle could also take up chemicals from the water present at the SWMU. These pathways are evaluated as part of the future residential scenario.

14.4.1.6. EPA default exposure parameters were used to estimate intakes of the COPCs. The parameters used in estimating intakes are presented in Appendix K.

14.4.2. Risk Characterization

14.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks, hazard indices, and blood lead levels for the potential receptors at SWMU 45. The methods for calculating the risks are discussed in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

14.4.2.2. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable (unless there are reasons to believe the risks have been underestimated), a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is indicative that adverse health effects are possible. Blood lead levels of 10 micrograms per deciliter (µg/dl) is a benchmark concentration for children, based on reduced intelligence quotients and growth rates (ATSDR, 1989; USEPA, 1994). See Section 3.2.6. for a discussion of the calculation of blood lead concentrations.

14.4.2.3. In addition to the calculated estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The

following paragraphs discuss the risk estimates for current Depot personnel and potential TEAD-N residents.

14.4.2.4. Depot Personnel. As shown on Table 14-4, the excess lifetime cancer risk for Depot workers exposed to the sediment and surface water at SWMU 45 was estimated to be 6×10^{-7}, which is less than benchmark of 1×10^{-6}. The calculated cancer risk is dominated by ingestion of arsenic in the sediment. The hazard index was estimated at 0.008 indicating that no adverse effects are anticipated. Hazard quotients could not be calculated for several metals for the inhalation pathway due to the lack of reference doses. However, the exposure doses are no greater than 1×10^{-6} mg/kg/day, and the potential for adverse effects is considered minimal (see Section 14.4.3.). A summary of the risks by exposure pathway and relevant uncertainties is presented in Table 14-5. A blood lead concentration was not calculated for the Depot worker, as models estimating this concentration assume continuous rather than intermittent exposure. The sediment exposure point concentration of 470 mg/kg, while sometimes associated with elevated blood lead concentrations, is unlikely to be significant for a trespasser for two reasons. First, the intermittent nature of the exposure will reduce blood lead levels. Second, elevated blood lead levels with soil concentrations in this range are generally expected to be associated with only children below the age of six. Therefore, no adverse health effects are expected from lead for Depot workers.

14.4.2.5. Potential Future Construction Workers. Potential future construction workers are assumed to be exposed to COPCs in the soil from a depth of 0 to 12 feet during excavation activities. The estimated excess lifetime cancer risk was 3×10^{-6} (Table 14-6). Most of the cancer risk is from the ingestion and inhalation of arsenic. Arsenic is a Class A (known human) carcinogen which adds to the significance of the risk estimates, although its carcinogenicity was identified at very high exposure doses that may not be relevant here. Likely overestimates in soil ingestion rates and dust concentrations (See Section 14.4.3) indicate that more accurate estimates of these parameters would reduce the cancer risk to less than 1×10^{-6}. The likelihood of this hypothesis is further supported by a cancer risk estimate of 9.6×10^{-7} using CTE parameters (see Table 14-7).

14.4.2.6. The total hazard index for potential construction workers was estimated to equal 0.4 (Table 14-6), indicating that adverse health effects are not expected. While the inhalation exposure pathway has not been accounted for due to the absence of inhalation reference doses for the COPCs, the exposure doses are in a range where adverse health

TABLE 14-4

SWMU 45 - STORMWATER DISCHARGE AREA
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CURRENT DEPOT PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration Sediment (mg/kg)	Exposure Point Concentration Surface Water (μg/l)	Exposure Point Concentration Soil (mg/kg)	Cancer Risk Ingestion Sediment	Cancer Risk Dermal Sediment	Cancer Risk Ingestion Surface Water	Cancer Risk Dermal Surface Water	Cancer Risk Inhalation Soil	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	6.40E+01	7.70E+00	NA	5E-07	6E-08	6E-08	5E-09	NC	6E-07	98
Cadmium	6.00E+00	ND	2.98E+00	NC	NC	NC	NC	2E-10	2E-10	<1
Bis(2-ethylhexyl)phthalate	ND	2.00E+01	NA	NC	NC	1E-09	1E-08	NC	1E-08	2
4-Methylphenol	ND	1.50E+00	ND	NC	NC	NC	NC	NC	NC	NC
Pathway Total				5E-07	6E-08	6E-08	2E-08	2E-10		
Percent of Total				78	10	10	3	<1		
							Total Cancer Risk:		6E-07	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration Sediment (mg/kg)	Exposure Point Concentration Surface Water (μg/l)	Exposure Point Concentration Soil (mg/kg)	Hazard Index Ingestion Sediment	Hazard Index Dermal Sediment	Hazard Index Ingestion Surface Water	Hazard Index Dermal Surface Water	Hazard Index Inhalation Soil	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	6.40E+01	7.70E+00	NA	3E-03	3E-04	3E-04	3E-05	NC	3E-03	39
Barium	NA	1.00E+02	NA	NC	NC	2E-05	3E-05	NC	5E-05	<1
Cadmium	6.00E+00	ND	2.98E+00	7E-05	1E-04	NC	NC	NC	2E-04	2
Chromium(III)	4.50E+01	ND	3.33E+01	5E-07	2E-06	NC	NC	NC	2E-06	<1
Cyanide	NA	1.20E+01	NA	NC	NC	7E-06	4E-06	NC	1E-05	<1
Lead	4.70E+02	1.60E+00	2.61E+02	NC	NC	NC	NC	NC	NC	NC
Manganese	NA	5.60E+01	NA	NC	NC	1E-04	4E-04	NC	5E-04	6
Mercury	1.02E-01	ND	7.50E-02	4E-06	3E-06	NC	NC	2E-07	8E-06	<1
Silver	NA	NA	7.10E-02	NC	NC	NC	NC	NC	NC	NC
Thallium	2.00E+01	ND	NA	3E-03	4E-04	NC	NC	NC	3E-03	41
Vanadium	2.80E+01	ND	NA	5E-05	6E-04	NC	NC	NC	7E-04	8
Bis(2-ethylhexyl)phthalate	ND	2.00E+01	NA	NC	NC	1E-05	1E-04	NC	1E-04	2
4-Methylphenol	ND	1.50E+00	ND	NC	NC	4E-06	4E-06	NC	7E-06	<1
Toluene	NA	6.80E-01	ND	NC	NC	4E-08	2E-07	NC	2E-07	<1
Pathway Total				6E-03	1E-03	5E-04	6E-04	2E-07		
Percent of Total				69	18	6	7	<1		
							Total Hazard Index:		8E-03	
					Blood Lead Concentration μg/dl (95th percentile):				NA	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
ND Not detected
RME Reasonable maximum exposure

TABLE 14-5

TEAD-N BASELINE RISK ASSESSMENT
SWMU 45–STORMWATER DISCHARGE AREA PATHWAY EVALUATION

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (µg/dl)	Key Chemicals[a]
DEPOT WORKER						
Sediment Ingestion	Current unlikely	Medium/Neutral	0.006	5×10^{-7}		Arsenic, thallium
Sediment Dermal	Current unlikely	Medium/Neutral	0.002	7×10^{-8}		
Surface Water Ingestion	Current unlikely	Medium/Neutral–High	0.0005	6×10^{-8}		
Surface Water Dermal	Current unlikely	Medium/Neutral	0.0006	2×10^{-8}		
Soil Inhalation	Current unlikely	High/High	0.0000002	2×10^{-10}	4.0	Arsenic, thallium
CONSTRUCTION WORKER						
Soil Ingestion	Future unlikely	Medium High	0.4	2×10^{-6}		
Soil Dermal	Future unlikely	High/High	0.01	2×10^{-8}		
Soil Inhalation	Future unlikely	Medium/High	0.00008	4×10^{-8}		
TEAD-N RESIDENT					10.1	
Soil Ingestion	Future unlikely	Medium/High	5	1×10^{-4}		Arsenic, cadmium, thallium
Soil Dermal	Future unlikely	Low/High	0.07	2×10^{-6}		
Soil Inhalation	Future unlikely	High/High	0.00003	4×10^{-6}		
Groundwater Ingestion	Future unlikely	Medium/Neutral	0.4	NA		
Vegetable Crops	Future unlikely	High/Neutral	4	3×10^{-4}		
Beef	Future unlikely	High/Neutral	0.006	4×10^{-7}		

NA Not applicable; no carcinogenic chemicals of potential concern by this exposure route
NC Not calculated
TEAD-N Tooele Army Depot North Area
(a) Contribute 10 percent or more to total carcinogenic risk or hazard index

TABLE 14-6

SWMU 45 - STORMWATER DISCHARGE AREA
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	3.72E+01	2E-06	2E-08	8E-07	3E-06	99
Cadmium	4.16E+00	NC	NC	4E-08	4E-08	1
Pathway Total		2E-06	2E-08	8E-07		
Percent of Total		73	<1	27		
			Total Cancer Risk:		**3E-06**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	3.72E+01	3E-01	3E-03	NC	3E-01	81
Cadmium	4.16E+00	1E-02	1E-03	NC	1E-02	3
Chromium (III)	3.38E+01	8E-06	2E-06	NC	1E-05	<1
Lead	3.16E+02	NC	NC	NC	NC	NC
Mercury	7.22E-02	6E-04	3E-05	8E-05	7E-04	<1
Silver	1.27E+00	6E-04	5E-05	NC	6E-04	<1
Thallium	1.39E+01	4E-02	4E-04	NC	4E-02	11
Vanadium	2.25E+01	8E-03	7E-03	NC	1E-02	4
Pathway Total		4E-01	1E-02	8E-05		
Percent of Total		97	3	<1		
			Total Hazard Index:		**4E-01**	
	Blood Lead Concentration μg/dl (95th percentile):				**4.0**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 14-7

SWMU 45 - STORMWATER DISCHARGE AREA
CTE CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	3.72E+01	6E-07	4E-09	3E-07	9E-07	98
Cadmium	4.16E+00	NC	NC	1E-08	1E-08	2
Pathway Total		6E-07	4E-09	3E-07		
Percent of Total		66	<1	34		
			Total Cancer Risk:		**9.6E-07**	

Hazard Index and Blood Lead Concentration

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	3.72E+01	8E-02	5E-04	NC	8E-02	82
Cadmium	4.16E+00	3E-03	2E-04	NC	3E-03	3
Chromium (III)	3.38E+01	2E-06	3E-07	NC	3E-06	<1
Lead	3.16E+02	NC	NC	NC	NC	NC
Mercury	7.22E-02	2E-04	6E-06	3E-05	2E-04	<1
Silver	1.27E+00	2E-04	9E-06	NC	2E-04	<1
Thallium	1.39E+01	1E-02	6E-05	NC	1E-02	11
Vanadium	2.25E+01	2E-03	1E-03	NC	3E-03	3
Pathway Total		1E-01	2E-03	3E-05		
Percent of Total		98	2	<1		
			Total Hazard Index:		**1E-01**	
	Blood Lead Concentration µg/dl (50th percentile):				**2.2**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
CTE Central tendency exposure

effects are unlikely (see the discussion of uncertainties in Section 14.4.3; Appendix K summarizes the exposure doses). The concentration of lead in blood was estimated to be 4.0 μg/dl.

14.4.2.7. Potential Future TEAD-N Resident. For SWMU 45, the cancer risk from all exposure pathways was estimated to equal 4 x 10^{-4}, and the hazard index was estimated to equal 9. As shown in Table 14-8, the excess lifetime cancer risk for potential future residents exposed to soil at SWMU 45 was estimated to be 1 x 10^{-4}. The calculated cancer risk is dominated by ingestion of arsenic in soil. The total hazard index from potential exposure to soil was estimated to equal 5 and the concentration of lead in blood was estimated to be 10.1 μg/dl.

14.4.2.8. The cancer risk results from the presence of arsenic at 95 mg/kg in one sediment sample; it was present within its background range in all other surface soil and sediment samples. The hazard index is based on the ingestion of arsenic and thallium in soil and sediment. While thallium has been indicated as being present above the background threshold, its UCL concentration of 16 mg/kg is within the background range for other areas of the Depot. Therefore, the hazard quotient for thallium may represent a background risk. Hazard quotients could not be calculated for several metals for the inhalation pathway due to the lack of reference doses. However, the exposure doses are no greater than 1 x 10^{-6} mg/kg/day, and the potential for adverse effects is considered minimal (see Section 14.4.3.).

14.4.2.9. The estimated blood-lead level of 10.1 μg/dl is derived from lead detected in sediment samples. Elevated lead concentrations were present in all samples.

14.4.2.10. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 45, the estimated cancer risk is 3 x 10^{-4} and the hazard index is 4 (Table 14-8), primarily due to arsenic and cadmium. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has a high degree of uncertainty because of uncertainties in the plant uptake factors (see Section 14.4.3.).

14.4.2.11. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 45, the estimated cancer risk is 4 x 10^{-7} and the hazard index is 0.006 (Table 14-8). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 45 if

TABLE 14-8

SWMU 45 - STORMWATER DISCHARGE AREA
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT

Cancer Risk

Chemical	Exposure Point Concentration Groundwater (µg/l)	Exposure Point Concentration Soil (mg/kg)	Exposure Point Concentration Surface Water (µg/l)	Cancer Risk Ingestion Groundwater	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Arsenic	NA	4.69E+01	7.70E+00	NC	1E-04	2E-06	3E-06	3E-04	4E-07	4E-04	100
Cadmium	ND	5.00E+00	ND	NC	NC	NC	2E-07	NC	NC	2E-07	<1
Bis(2-ethylhexyl)phthalate	ND	ND	2.00E+01	NC	NC	NC	NC	NC	5E-09	5E-09	<1
4-Methylphenol	ND	ND	1.50E+00	NC	NC	NC	NC	NC	NC	NC	NC
Pathway Total				NC	1E-04	2E-06	4E-06	3E-04	4E-07		
Percent of Total				NC	32	<1	<1	67	<1		
								Total Cancer Risk:		**4E-04**	

Hazard Index and Blood Lead Concentration (Child)

Chemical	Exposure Point Concentration Groundwater (µg/l)	Exposure Point Concentration Soil (mg/kg)	Exposure Point Concentration Surface Water (µg/l)	Hazard Index Ingestion Groundwater	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Arsenic	NA	4.69E+01	7.70E+00	NC	2E+00	1E-02	NC	3E+00	5E-03	5E+00	50
Barium	7.77E+01	NA	1.00E+02	6E-02	NC	NC	NC	NC	3E-05	6E-02	<1
Cadmium	ND	5.00E+00	ND	NC	6E-02	6E-03	NC	1E+00	1E-07	1E+00	15
Chromium (III)	5.31E+00	3.88E+01	ND	3E-04	5E-04	8E-05	NC	2E-04	5E-09	1E-03	<1
Cyanide	ND	ND	1.20E+01	NC	NC	NC	NC	NC	NC	NC	NC
Lead	ND	3.85E+02	1.60E+00	NC	NC	NC	NC	NC	NC	NC	NC
Manganese	2.10E+01	NA	5.60E+01	2E-01	NC	NC	NC	NC	2E-05	2E-01	2
Mercury	ND	8.54E-02	ND	NC	4E-03	2E-04	3E-05	1E-02	8E-09	2E-02	<1
Selenium	3.73E+00	NA	ND	4E-02	NC	NC	NC	NC	NC	4E-02	<1
Silver	ND	1.50E+00	ND	NC	4E-03	3E-04	NC	NC	NC	4E-03	<1
Thallium	NA	1.62E+01	ND	NC	3E+00	2E-02	NC	3E-01	5E-04	3E+00	31
Vanadium	6.94E+00	2.38E+01	ND	5E-02	4E-02	3E-02	NC	NC	NC	1E-01	1
Zinc	7.23E+01	NA	ND	1E-02	NC	NC	NC	NC	NC	1E-02	<1
Bis(2-ethylhexyl)phthalate	ND	ND	2.00E+01	NC	NC	NC	NC	NC	1E-04	1E-04	<1
4-Methylphenol	ND	ND	1.50E+00	NC	NC	NC	NC	NC	1E-07	1E-07	<1
Toluene	ND	ND	6.80E-01	NC	NC	NC	NC	NC	6E-09	6E-09	<1
Pathway Total				4E-01	5E+00	7E-02	3E-05	4E+00	6E-03		
Percent of Total				4	49	<1	<1	46	<1		
								Total Hazard Index:		**9E+00**	
				Blood Lead Concentration µg/dl (95th percentile):						**10.1**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
ND Not detected
RME Reasonable maximum exposure
TEAD-N Tooele Army Depot North Area

they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

14.4.3. Uncertainties

14.4.3.1. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical (tetraethyl lead) with a reference dose below 1×10^{-6} mg/kg/day, and this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic effects via inhalation of metals with exposure doses greater than 1×10^{-6} was examined on a case-by-case basis. The results of this evaluation were presented in Section 14.4.2. Exposure doses are summarized in Appendix K.

14.4.3.2. Uncertainties associated with Depot personnel are most important where they may underestimate risk. It was assumed that a Depot worker would be exposed once a month during warm weather months. While this is a reasonable frequency, a higher rate is possible. On the other hand, overestimates regarding the 25-year exposure duration and the area of skin covered by sediment or surface water make it unlikely that a significant underestimate of risk has occurred.

14.4.3.3. Uncertainties associated with the exposure dose for a construction worker are high. As discussed in Section 5.0, a reasonable ingestion rate is probably a factor of 3.5 less than the 480 mg/day used in this risk assessment. Also the bioavailability of the contaminants in the soil is likely to be less than the 100 percent assumed for the BRA, further reducing the actual dose and corresponding risk. The BRA assumed a dust

concentration of 1 mg/m^3, which is the upper end of the range of dust levels measured while digging test pits at SWMU 1 (although most of the time dust levels were lower).

14.4.3.4. Uncertainties in the evaluation of the residential scenario are dependent on the medium of exposure. Because the SWMU could be a wet play area, soil and sediment may cover a high percentage of exposed skin. The soil ingestion rate of 200 mg/day is an overestimate for most children, although pica children may ingest more. Inhalation exposure is probably a great overestimate, as this SWMU offers little potential for generating dust.

14.4.3.5. The uncertainties associated with groundwater ingestion are low. The drinking water ingestion rate is probably accurate within a factor of two. Exposure by young children makes up most of the total exposure, and it is reasonable for young children to be at home and obtain drinking water from the same source most of the year. However, use of groundwater is less likely than the residential scenario in general in that a private well to a depth of over 300 feet is improbable. The Depot water supply would probably become a municipal supply.

14.4.3.6. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990). These factors likely lead to an uncertainty of 1 to 2 orders of magnitude in the uptake estimates for metals. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from incidentally ingested soil to beef.

14.4.4. Recommendations

14.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Allow unrestricted use of this site as long as it remains part of the depot

- Evaluate the need for institutional controls and/or corrective action in a Corrective Measures Study should this land no longer be controlled by the depot.

14.5 ECOLOGICAL RISK ASSESSMENT

14.5.0.1. This section discusses the results of the Tier 1 and Tier 2 evaluations for SWMU 45. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4.

14.5.1. Tier 1

14.5.1.1. Ecological Receptors. The dominant vegetation consists of rubber rabbitbrush, crested wheatgrass, Canada bluegrass, yellow sweetclover, gumweed and poison hemlock. On the slopes, cheatgrass and crested wheatgrass are dominant. One large box elder tree and one Siberian elm tree are rooted along the drainage. A small pond has developed from stormwater discharge via a drainage pipe under the railroad tracks. Increased soil moisture has also allowed for the common cattail, reed canarygrass, and willows to become established. The pond area and associated soils that become inundated during runoff events is approximately 0.1 acres in size. The mapped soil and range type are:

Range Site: Semi-Desert Gravelly Loam
Soil Type: Hiko Peak gravelly loam with 2-15 percent slopes

14.5.1.2. Expected Climax Vegetation. The range site describes the climax vegetation expected to occur at each site due to the combined influence of environmental factors that are characteristic of the site. This area is mapped as a semi-desert gravelly loam by the U.S. Soil Conservation Service, but the immediate area is, in fact, an inclusion of the loamy bottom range site within the above range site. Characteristic vegetation of the loamy bottom range site includes basin big sagebrush, bluebunch wheatgrass, rubber rabbitbrush and basin wildrye (USSCS, 1991).

14.5.1.3 Wildlife. No reptiles were observed at SWMU 45 but, based on sightings elsewhere at the Depot, the wandering garter snake may be an inhabitant at or near

SWMU 45. Because of the moisture, the northern leopard frog (an amphibian) is also a potential inhabitant of SWMU 45.

14.5.1.4. The most common small mammal at SWMU 45 is likely the valley pocket gopher. Pocket gopher mounds were abundant on the hill slopes and slopes of the railroad tracks. The deer mouse and the Great Basin pocket mouse may also be common since habitat conditions are optimum: sandy loam soils with gravels and grassy/weedy waste areas around the pond (personal communication, Dr. J. Merino). Local cottontail rabbits and jackrabbits probably frequent this SWMU for water.

14.5.1.5. Species of large mammals in the vicinity likely use the Stormwater Discharge Area as a source of water, also. Mule deer commonly graze around the Stormwater Discharge Area as evidenced by numerous tracks, the condition of the vegetation around the pond, and sightings by field personnel. The box elder seedlings have the appearance of shrubs because of the heavy browsing and subsequent multiple shoot growth. Other species that may use this water source include coyotes, skunks, raccoons, and pronghorn antelope.

14.5.1.6. Raptors such as the golden eagle, American kestrel, ferruginous hawk, peregrine falcon, prairie falcon, harrier hawk, red-tailed hawk, and great-horned owl have been observed in other areas of TEAD-N. Because of the typical range of these species during foraging/hunting activities, they may be present at SWMU 45 on an intermittent basis.

14.5.1.7. No passerine or other birds were observed during the site visit. The sage grouse, a State of Utah sensitive species, may inhabit the SWMU. Many other non-game birds such as crows and red-winged blackbirds, and several families of passerine birds would not be unexpected.

14.5.1.8. SWMU 45 is likely to attract highly mobile receptors on an intermittent basis because of the presence of fresh water in the semi-desert environment. Receptors with high mobility include birds and large mammals such as the deer and coyote. These receptors may use the surface water at SWMU 45 as a primary source of water and/or a hunting ground.

14.5.1.9. Results of the Tier 1 Ecological Assessment. The field surveys indicate that the vegetation at SWMU 45 appears abundant and healthy, with no signs of distress.

Some impacts have been observed related to physical activities at this site related to the placement of fill for the adjacent railroad tracks; these impacts are not within the scope of this assessment. The ecological assessment, therefore, addresses only the potential adverse impact to the wildlife receptors; it is not deemed necessary to address the ecological effects on the vegetation. The ecological assessment is performed with the assumption that the wildlife receptors are not limited by the physical boundaries of the SWMU. Therefore, the spatial distribution of the detected chemicals at SWMU 45 is assumed to potentially expose wildlife species that occur or that may potentially occur at the TEAD-N facility as a whole. The results of the Tier 1 assessment indicate that the detected levels of some of the chemicals at SWMU 45 warrant a Tier 2 evaluation.

14.5.2. Tier 2

14.5.2.1. The objective of the Tier 2 assessment is to further evaluate the Tier 1 COPECs by comparing the receptor's chemical exposure dose to a biological endpoint.

14.5.2.2. Exposure Analysis. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil; indirect exposure occurs via the food web, such as when a raptor consumes the mouse. SWMU 45 has surface water present, at least intermittently, so a surface water exposure pathway is potentially complete.

14.5.2.3. The reptiles potentially inhabiting SWMU 45 may be exposed via direct pathways (ingestion and dermal exposure to soil or water) and, to a lesser extent, via food web pathways (e.g. ingestion of contaminated insects). As prey, they may also expose predators.

14.5.2.4. Small mammals are predominantly exposed via direct pathways (ingestion of soil or water) and, to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators. Antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing) and, as prey, may expose predators. The coyote (a predator) is exposed predominantly via food web pathways.

14.5.2.5. The predominant route of exposure for the raptors is via food web pathways because they typically do not spend much time on the ground. The non-raptor birds are

exposed via food web pathways by ingestion of seeds, grasses, and by direct exposure to soil during preening.

14.5.2.6. Risk Characterization. The ecological risk characterization for the COPECs at SWMU 45 is based on the ecological toxicity quotient derived by comparing either the dose ingested by the indicator species or the chemical concentration in the soil to a biological endpoint. The ingestion pathway is associated with the greatest exposure at TEAD-N. The results indicate that lead in the soil and arsenic and lead in the sediment are the COPECs at SWMU 45 that have ETQs greater than 1.0. These estimated ETQs, however, are probably overestimations due to the uncertainties in the evaluation. The calculations were done with the assumption that the foraging area of the receptors is exclusively within the contaminated area at SWMU 45. This conservative assumption leads to a contaminant intake or dose that is significantly higher than what is actually being ingested by the receptors. The results of the ecological evaluation are shown in Appendix K.

14.5.2.7. When the foraging area exceeds the contaminated area, a correction factor that accounts for less than full-time exposure is required (deSesso, 1994). The mobility factor is a suggested method for estimating the fraction of time that a receptor may be exposed to a contaminant. The mobility factor is the ratio of the contaminated area to the foraging area and accounts for the effect of receptor mobility to the frequency and duration of exposure to the contaminated media. The areal extent of SWMU 45 is very small relative to the foraging area of the selected indicator species, thus significantly reducing the ETQs. Consequently, the potential for adverse impacts to the ecological receptors is diminished. The receptors that may have a high exposures are the less mobile receptors such as the reptile or small mammal species. The field surveys did not observe these species at SWMU 45 but the ecological assessment identifies them as potentially occurring at the site. The impact to less mobile terrestrial receptors at SWMU 45 is not significant enough to adversely affect the structure and function of the ecosystem due to the limited number of individuals potentially affected. In addition, the relatively low bioaccumulative potential for the metals retained for the ecological assessment make the potential for impacts to higher predator trophic levels unlikely. It is, therefore, recommended that SWMU 45 be proposed for no further ecological investigation.

14.5.2.8. Uncertainties. The evaluation does not take into account the frequency of exposure to the contaminant nor the effect of receptor mobility on the frequency and duration of contact with the contaminated media. The use of NOEL-type values as

surrogates for effective concentration has a significantly more conservative meaning as an indicator of risk.

14.5.3. Recommendations

14.5.3.1. Based on the preceding discussions, SWMU 45 is recommended for no further investigation regarding potential ecological effects.

15.0 OLD DISPENSARY DISCHARGE – BUILDING 400 (SWMU 48)

15.1 SITE BACKGROUND

15.1.0.1. Site Description. SWMU 48, a recently designated SWMU, encompasses the area where the TEAD Dispensary Building (previous Building 400) formerly stood. This location is approximately 300 feet northwest of the present TEAD-N clinic in the Administration Area of the Depot (Figure 15-1). Building 400, along with several other buildings, was razed in the mid-1980s as the old facility was replaced with the more modern clinic currently in use. Regulatory concerns regarding the disposal facilities and practices, especially regarding the X-ray development operations, prompted the designation of the Old Dispensary as a SWMU. Even though available plans show that waste streams from the X-ray operations were discharged to the sanitary system, the possibility exists that these, or other wastes, were disposed of into the adjacent stormwater lines.

15.1.0.2. The former Dispensary site is currently a flat, grass-covered area. Evidence of the facility's past existence is present in the form of an asphalt parking lot, and manholes used to access the water and sewer lines that once served the building. The former Building 400 was one of 10 buildings that previously stood in this area.

15.1.0.3. Operational Activities. Building 400 was constructed in 1945, and originally served as the hospital facilities Administration Building. It later served as a hospital facility for TEAD. Building 400 housed operating rooms, a sterilization room, X-ray rooms, a dental office, and associated office space.

15.1.0.4. Geology and Hydrology. Soils underlying the former Building 400 location are composed of gravelly loams and very gravelly loams of the Abela series (USSCS, 1991). Surface water drainage is toward the west and northwest. The approximate depth of groundwater is 420 feet bgs, and the direction of groundwater flow is toward the northeast (JMM, 1988). Depth to bedrock is approximately 1,200 feet bgs.

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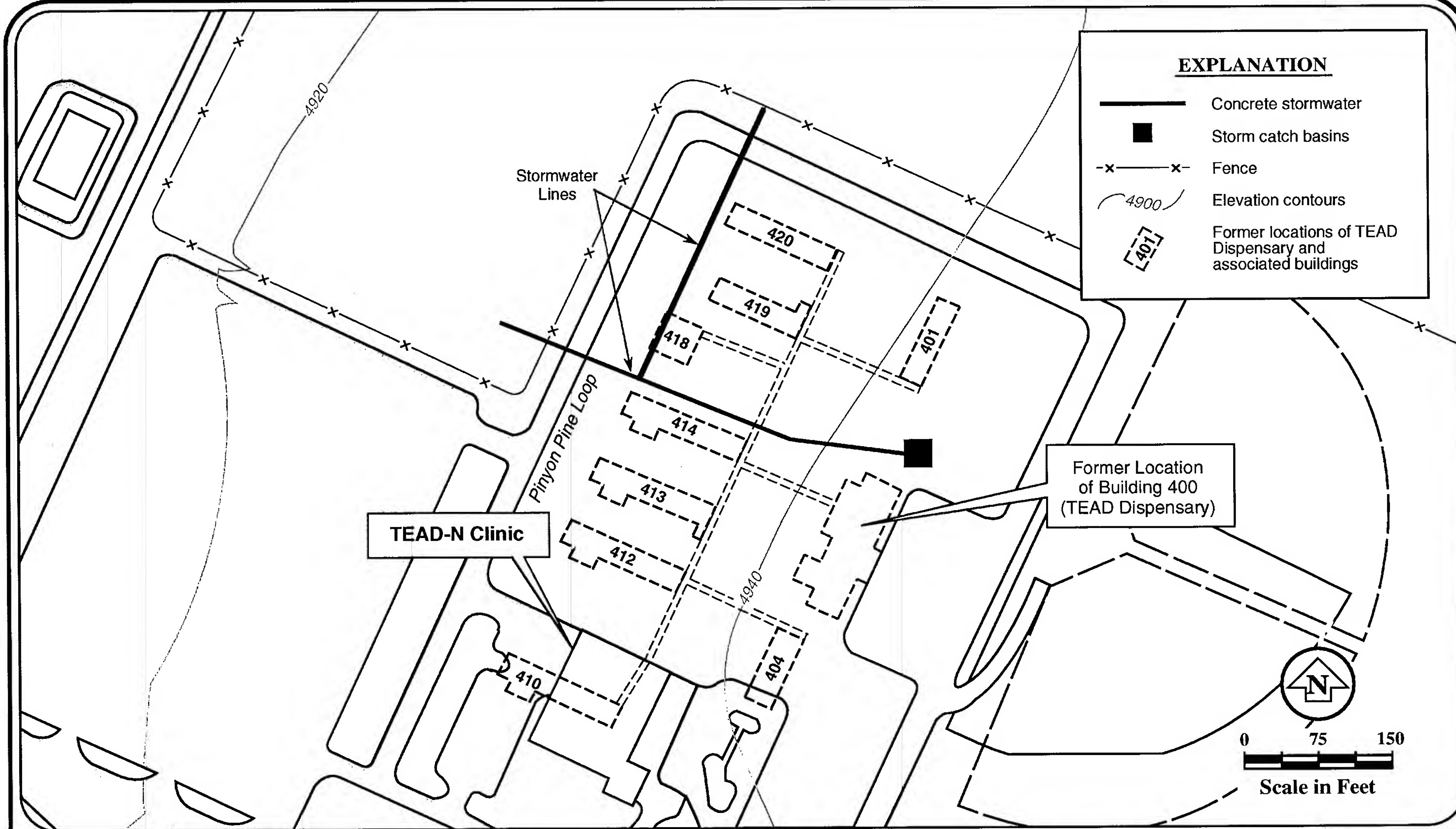

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TEAD-N RFI—GROUP A SWMUs
SWMU 48
OLD DISPENSARY DISCHARGE—BUILDING 400
LOCATION MAP
FIGURE 15-1

15.2 PREVIOUS INVESTIGATIONS AND RFI ACTIVITIES

15.2.1. Previous Investigations

15.2.1.1. No investigations of SWMU 48 have been conducted prior to RFI sampling in May 1994, since this area has only recently been designated a SWMU. The former dispensary facility was targeted for environmental sampling to investigate the possibility that potential contaminants, related to X-ray development solutions, were discharged into the nearby stormwater system.

15.2.2. RFI Sampling Summary

15.2.2.1. Phase I Sampling. This facility had not yet been targeted for environmental sampling when the Phase I investigation was conducted in 1992.

15.2.2.2. Phase II Sampling. Two 10-foot soil borings were drilled at SWMU 48, one at each of the outfall locations of the stormwater system in a nearby field. Two soil samples were collected from each boring, for a total of four soil samples. The samples were collected from 0.5 to 4 feet and 8 to 9.5 feet bgs at SB-48-001, and 2 to 4 feet and 8 to 10 feet bgs at SB-48-002. The first sample at SB-48-002 was collected at 2 feet bgs because the bottom of the outfall was estimated to be at 2 feet bgs. Each sample was submitted for metals, VOCs, SVOCs, pesticides/PCBs, and TPH analyses.

15.2.2.3. Data Completeness Evaluation. The results of the Phase II data review performed by the USAEC chemistry group and the Montgomery Watson chemists indicate that all of the SWMU 48 data are usable. Three soil samples were qualified as estimated for several inorganic and organic parameters by Montgomery Watson chemists due to MS/MSD nonconformances and blank contamination. No data for this SWMU were rejected; therefore, 100 percent completeness was achieved for all parameters. Further details concerning the data review are presented in Appendix E of this document.

15.2.2.4. The sampling efforts followed the approved project work plans (Montgomery Watson, 1993a and 1993b) without significant deviation and DQOs were met. Due to this, no data gaps have been identified and additional sampling is not required to evaluate the need for environmental remediation.

15.3 CONTAMINATION ASSESSMENT

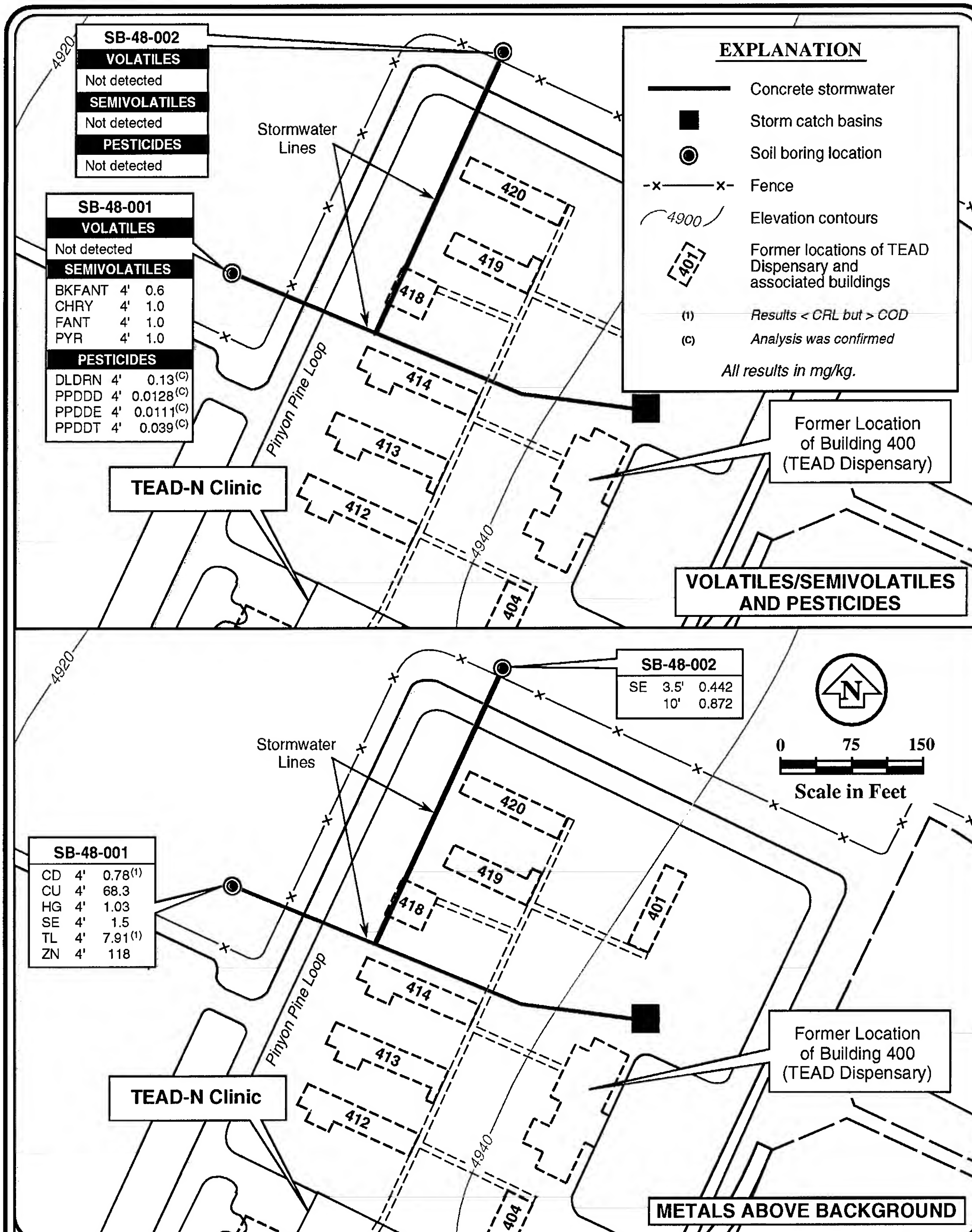
15.3.1. RFI Sampling Results

15.3.1.1. Contaminants detected above background in the soils included several metals and pesticides. Two VOCs (methylene chloride and acetone) were detected in low concentrations (less than 0.050 mg/kg). The acetone result is considered not detected due to associated method blank contamination. The common occurrence of methylene chloride as a laboratory contaminant at this concentration makes its detection suspect for further use in the assessment.

15.3.1.2. Elevated metals were detected in both of the shallow intervals in the borings, as shown in Figure 15-2. Cadmium, copper, zinc, mercury, thallium, and selenium were detected at elevated concentrations in SB-48-001; only selenium was detected at elevated levels in SB-48-002. These elevated levels did not persist to depth in the boreholes. Concentrations of beryllium that exceed available risk-based soil guidance thresholds (USEPA, 1994a) were detected in the surface intervals of both borings. However, these concentrations are both below the established background levels for beryllium in naturally occurring coarse-grained soils at TEAD-N and are not presented on the analytical results figures.

15.3.1.3. Traces of several pesticides were detected in the 0.5 to 4-foot interval of SB-48-001, the highest concentration being dieldrin (DLDRN) at 0.13 mg/kg (Figure 15-2). This level of dieldrin exceeds the available risk-based guidance threshold for residential soils (0.04 mg/kg).

15.3.1.4. Neither PCBs nor TPH were detected in either of the soil borings at SWMU 48. However, low levels of several PAHs were detected in a duplicate sample collected from the 0.5 to 4-foot interval of SB-48-001; 1 mg/kg of chrysene, fluoranthene, and pyrene were detected and benzo(k)fluoranthene was detected at 0.6 mg/kg. None of these compounds were detected in the duplicated sample. These concentrations are well below the available risk-based guidance threshold for residential soils used for comparison purposes in is report (USEPA, 1994a).



TEAD-N RFI—GROUP A SWMUs

SWMU 48

OLD DISPENSARY DISCHARGE—BUILDING 400

ANALYTICAL RESULTS FOR SHALLOW SOILS

FIGURE 15-2

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15.3.2. Nature and Extent of Contamination

15.3.2.1. Soil boring results from the two locations at SWMU 48 show that elevated levels of some metals and pesticides are present at the outfall locations of the stormwater system draining the present-day parking area north of the TEAD-N clinic. These constituents are probably not related to any waste disposal practices at the former TEAD Dispensary, but may have occurred by concentration of stormwater runoff from surface areas where these constituents were present. The pesticide compounds may have originated from normal TEAD spraying activities in this area.

15.3.2.2. The contaminants detected do not persist below 2 feet bgs in either borehole. Even though the groundwater underlying SWMU 48 was not sampled, the depth to the water table, the low concentrations of contamination, and the lack of contaminants below 2 feet bgs make it unlikely that groundwater contamination has occurred here due to site activities.

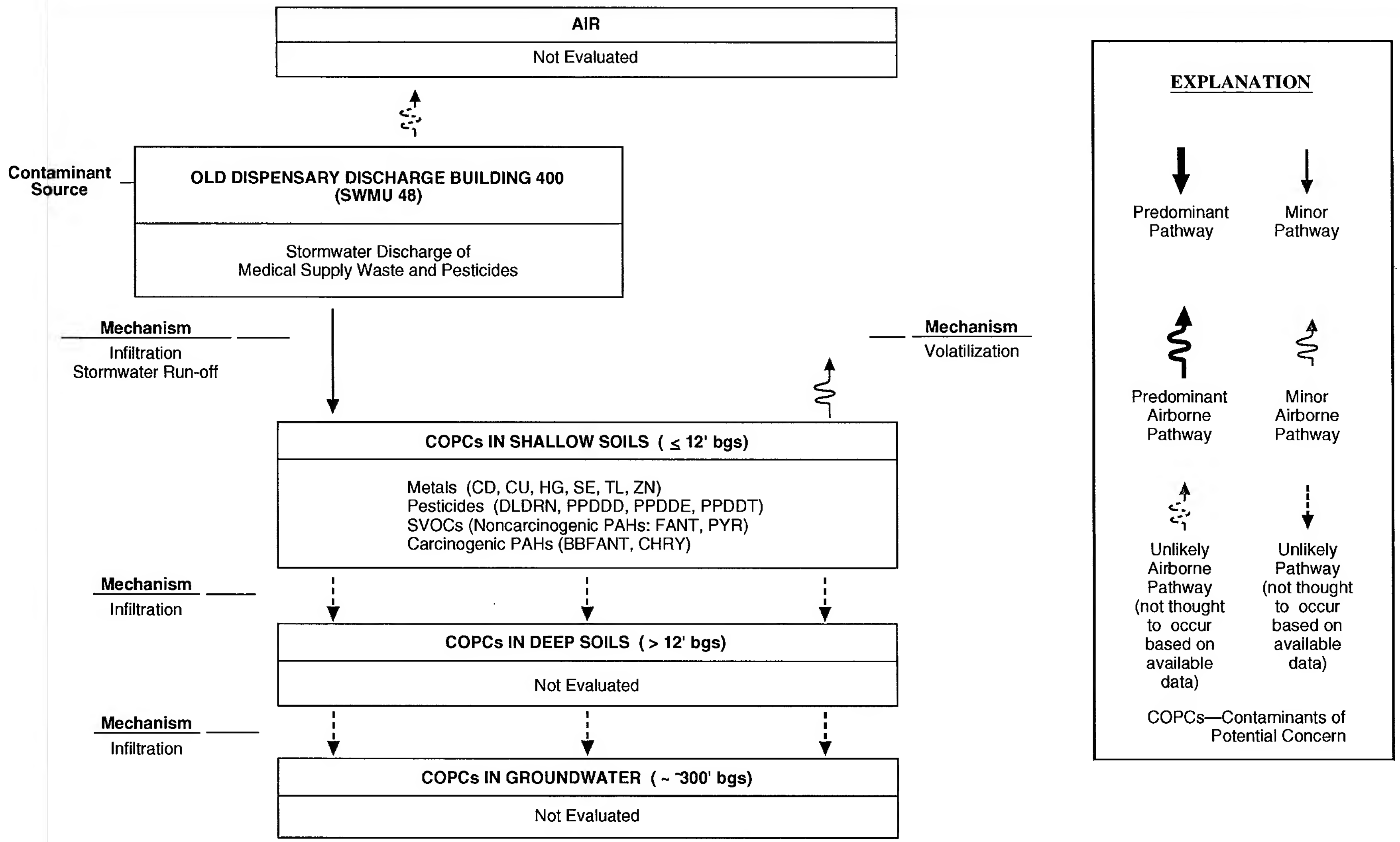
15.3.3. Selection of COPCs and COPECs

15.3.3.1. Identification of COPCs. The COPCs for SWMU 48 are those compounds detected above background concentrations that are not associated with sampling or laboratory contamination. They include the metals cadmium, copper, mercury, selenium, thallium, and zinc. The organics include the carcinogenic PAHs benzo(k)fluoranthene chrysene, the non-carcinogenic PAHs fluoroanthene and pyrene, and the pesticides dieldrin, p,p'-DDD, p,p'-DDE, and p,p'-DDT.

15.3.4. Contaminant Fate and Transport

15.3.4.1. As discussed in section 15.3.3., the potential contaminants of concern at SWMU 48 include metals, pesticides and PAHs. Table 3-4 briefly describes the fate and transport characteristics for each of the contaminants of potential concern. The remainder of this section will present a conceptual model of contaminant fate and transport at SWMU 48 and the fate and transport of the contaminants of potential concern.

15.3.4.2. Conceptual Model. A conceptual site model of contaminant transport (Figure 15-3) has been developed based on the physical site characteristics presented in Section 2.0 and the contamination assessment presented above. This model displays the potential



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TEAD-N RFI—GROUP A SWMUs
OLD DISPENSARY DISCHARGE AREA
BUILDING 400—SWMU 48
CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT
FIGURE 15-3

routes of migration of contaminants from the surface soil and unsaturated zone to the underlying groundwater. The predominant pathways are shown with bold arrows, the minor pathways in which contaminants may move in low concentrations are shown with gray arrows, and the dashed gray arrows show pathways that appear to be unlikely based on currently available data. Very low levels of contamination at SWMU 48 have been released to the surface and shallow soils from stormwater runoff from the asphalt parking area. The surface soils and shallow soils at SWMU 48 consist of sand, silty sand and gravel. Surface runoff is toward the west and northwest and the depth to groundwater is over 400 feet bgs.

15.3.4.3. Fate and Transport of Metals. Based on the low concentrations of the metals above background and other site conditions, it is highly unlikely that metals will migrate to the groundwater, or even to deeper soil horizons. The transport potential of metals is low because of the low amounts of precipitation, high evaporation rates, oxidizing conditions in the shallow soils, and neutral to slightly basic pH soils, and because groundwater is more than 400 feet below the ground surface. Off-site migration of metal contaminants via a surface-water pathway is expected to be minimal based on the low concentrations of these contaminants in the source areas. The metal contaminants at the surface are not expected to provide significant quantities of particulates to the air pathway.

15.3.4.4. Fate and Transport of Pesticides. Table 3-4 briefly describes the fate and transport characteristics of pesticides. Typically, pesticides will strongly adsorb to soils and will resist leaching to deeper soil horizons and to groundwater as indicated by their high K_{OC} partitioning coefficients (see Table 3-3). Pesticides tend to volatilize slowly from surface soil, which may be a significant fate process. Pesticides may adsorb to particulates and be transported by the air pathway where they may very slowly oxidize and be removed by wet/dry deposition. Pesticides are resistant to biodegradation and are persistent in the environment.

15.3.4.5. Fate and Transport of PAHs. Table 3-4 briefly describes the fate and transport characteristics of PAHs. Typically, PAHs will strongly adsorb to soils and will resist leaching to deeper soil horizons and to the groundwater as indicated by their high K_{OC} partitioning coefficient (see Table 3-3). Leaching to groundwater is highly unlikely at SWMU 48 because of the low concentrations, immobility of PAHs in the soil and the large vertical distance to groundwater (420 feet bgs). Low molecular weight PAHs (fluoranthene) tend to slowly volatilize from surface soil and may be a significant fate

process. The other medium- to high-molecular-weight PAHs have only limited volatilization potential and will likely not attenuate in the surface or shallow soils by this process. All PAH contaminants may adsorb to particulates and be transported by the air pathway where they may photodegrade or oxidize and be removed by wet/dry deposition. PAHs are also expected to slowly attenuate by biodegradation processes.

15.4 HUMAN HEALTH RISK ASSESSMENT

15.4.0.1. The methods used to estimate the risks associated with SWMU 48 are given in Human Health Risk Assessment Methodology (Section 3.2.6.). The COPCs were identified in the previous section. An evaluation of receptors and exposure pathways, and the characterization of risks (including a discussion of uncertainties for SWMU 48) is presented in the following sections. An important difference between this SWMU and the ones previously evaluated is that the data for this SWMU likely represents worst conditions.

15.4.1. Exposure Pathways and Receptors

15.4.1.1. Potential current and future exposure pathways are summarized in Figure 15-4 and Tables 15-1 and 15-2. Because the area is covered with grass, there are no currently complete pathways. Construction workers engaged in intrusive work could be exposed to contaminants through ingestion, dermal, and inhalation routes. Depot workers could be exposed if the grass were removed and contamination exists at the surface. For the purposes of this assessment, samples from the upper intervals (up to a depth of 4 feet) in each boring are considered representative of surface conditions. If this area of the Depot were included in the closure parcel, the grass were removed, and contamination is present at the surface, then residents could be exposed as well.

15.4.1.2. SWMU 48 could be converted into an area where crops are grown and future residents could eat the fruits and vegetables that are grown. Another potential pathway involves the uptake of soil contaminants into grass, and then to cattle that may graze within the SWMU boundaries for four to six months per year. The cattle could graze on the grass and incidentally ingest surface soil, and people could subsequently eat the beef from the cattle. These pathways are evaluated as part of the future residential scenario.

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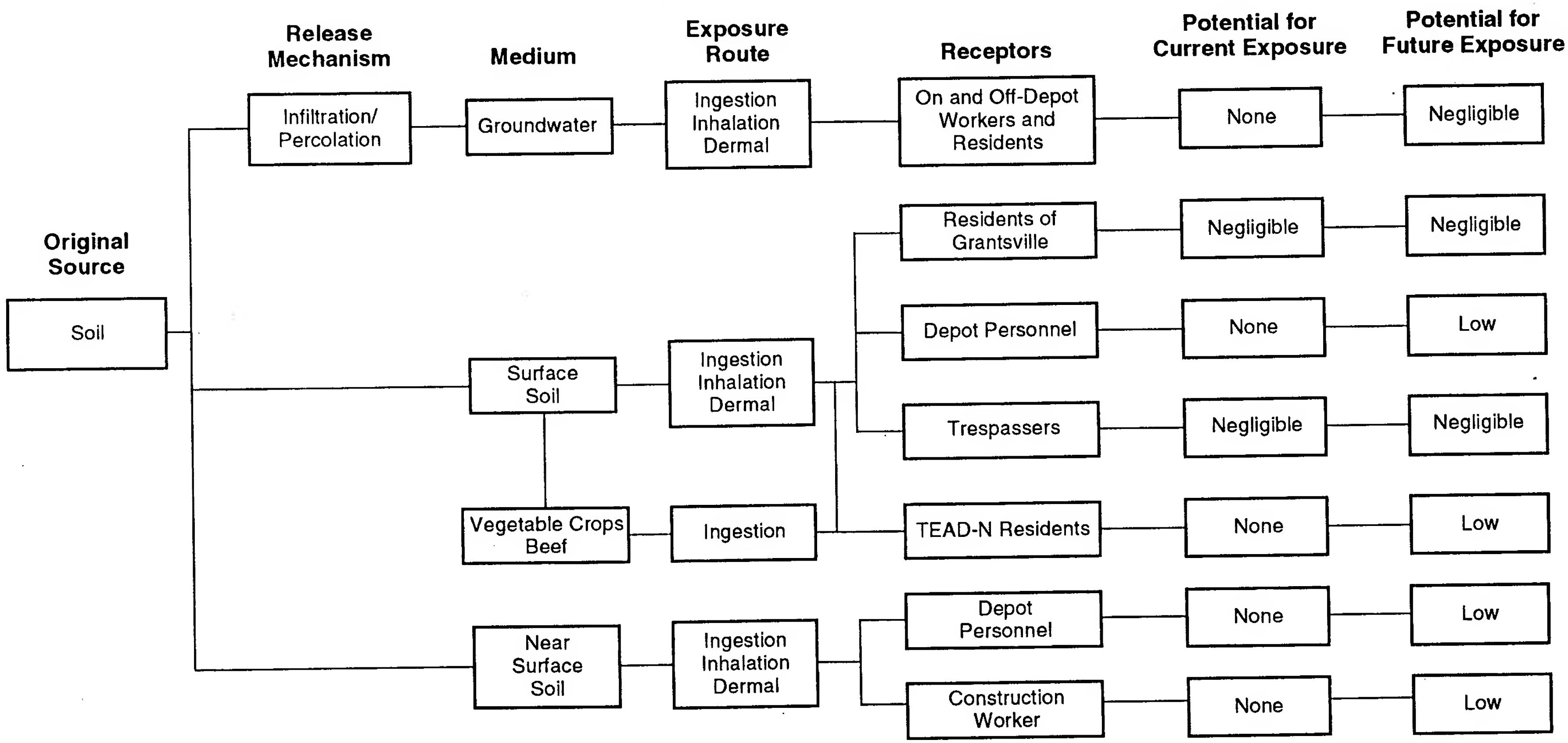

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TEAD-N RFI—GROUP A SWMUs
SWMU 48
OLD DISPENSARY DISCHARGE AREA—BUILDING 400
EXPOSURE PATHWAYS DIAGRAM
FIGURE 15-4

TABLE 15-1

TEAD-N CURRENT EXPOSURE PATHWAYS
SWMU 48: OLD DISPENSARY DISCHARGE - BUILDING 400

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is approximately 375 feet below the ground surface, evapotranspiration is high, and primary contaminants (i.e., pesticides such as DDT and PAHs) have low mobility.
Soil			
Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 48 is small and the amount of dust in Grantsville originating from SWMU 48 will be minuscule.
	Depot Personnel	Incidental ingestion of dust, inhalation, and dermal contact	No. Area is not currently used and is covered with grass.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. No evidence of trespassing observed.

TABLE 15-2

TEAD-N FUTURE EXPOSURE PATHWAYS
SWMU 48 OLD DISPENSARY DISCHARGE - BUILDING 400

Environmental Medium	Potential Receptors	Potential Exposure Routes	Evaluate Pathway?
Groundwater	On- and off-Depot workers and residents	Ingestion, inhalation, and dermal exposure through use of groundwater for drinking water and showering	No. Groundwater contamination is unlikely. Groundwater is approximately 375 feet below the ground surface, evapotranspiration is high, and primary contaminants (i.e. pesticides such as DDT and PAHs) have low mobility.
Soil Surface Soil	Residents of Grantsville	Inhalation of fugitive dust	No. SWMU 48 is small and the amount of dust in Grantsville originating from SWMU 48 will be minuscule.
	Future TEAD-N residents	Incidental ingestion of dust, inhalation, and dermal contact	Yes. While this SWMU is not within the existing closure parcel, residential development would be possible if this area of the Depot was closed in the future.
	Depot personnel	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Future use of this facility is uncertain.
		Ingestion of vegetable crops	Yes. Although soil is currently not suitable for growing crops, it could be made suitable in the future by diluting with peat or other soil amendments.
		Ingestion of beef from cattle grazing in this SWMU.	Yes. Cattle could take up contaminants directly from surface soil and from forage.
	Trespassers	Incidental ingestion of dust, inhalation, and dermal contact	No. Trespassers are not expected and the exposure will be less than for a future resident.
Near-Surface Soil	Construction workers	Incidental ingestion of dust, inhalation, and dermal contact	Yes. Near-surface soil is contaminated and future land use is uncertain.
Air	Future TEAD-N residents	Inhalation of volatile organics from subsurface soil	No. Volatile organics have not been detected. Dust exposure evaluated under soil.

TEAD-N Tooele Army Depot North Area

15.4.1.3. For the pathways that were evaluated quantitatively (see Tables 15-1 and 15-2), site-specific values or, where unavailable, EPA defaults were used to estimate intakes of the COPCs. The parameters used in estimating intakes are presented in Appendix K.

15.4.2. Risk Characterization

15.4.2.1. The risks to human health are discussed in the following sections in terms of excess lifetime cancer risks and hazard indices for the potential receptors at SWMU 48. The methods for calculating the risks are given in Section 3.2.6. The SWMU-specific parameters used in the risk calculations are given in Appendix K.

15.4.2.2. Typically, an excess lifetime cancer risk of less than 1×10^{-6} is acceptable, a risk greater than 1×10^{-4} is unacceptable (unless risks have been greatly overestimated or the potential for pathway completeness is minimal), and a risk between these values may or may not be acceptable. A hazard index less than one indicates that adverse health effects are unlikely, while a hazard index greater than one is suggestive that adverse health effects are possible.

15.4.2.3. In addition to the calculated estimates of risk, qualitative factors are an integral part of the overall risk evaluation and subsequent risk management decision process. Qualitative factors include whether an exposure pathway is complete, is likely to be completed, or is unlikely to be completed, and the degree of confidence in the risk estimates. When decisions regarding whether or not COPCs pose an unacceptable risk are made, the risk manager must consider all factors to make an informed decision. The following paragraphs discuss the risk estimates for potential Depot personnel, construction workers, and TEAD-N residents.

15.4.2.4. Depot Personnel. As shown on Table 15-3, the estimated excess lifetime cancer risk for future Depot personnel working at SWMU 48 is 1×10^{-6}. Most of the calculated cancer risk is from dermal exposure to dieldrin, which is classified as a B2 (probable human) carcinogen. The pathway has a moderate potential to be completed in the future if dieldrin is a surface contaminant.

15.4.2.5. It is likely that a realistic estimate of the cancer risk would be less than 1×10^{-6} due to overestimates of the exposure duration, exposure point concentrations, and ingestion rate, as explained in the discussion of uncertainties (Section 15.4.3.). The most likely source of a cancer risk greater than 1×10^{-6} would be dermal absorption greater

TABLE 15-3

SWMU 48 - OLD DISPENSARY DISCHARGE BUILDING 400
RME CANCER RISK AND HAZARD INDEX
FOR DEPOT PERSONNEL

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Carcinogenic PAHs	0.0053	7E-09	2E-08	NC	2E-08	2
Dieldrin	0.12	3E-07	9E-07	3E-09	1E-06	97
p,p-DDD	0.009	4E-10	1E-09	NC	1E-09	<1
p,p-DDE	0.01	6E-10	9E-10	NC	1E-09	<1
p,p-DDT	0.035	2E-09	5E-09	2E-11	7E-09	<1
Cadmium	0.734	NC	NC	8E-09	8E-09	<1
Pathway Total		3E-07	9E-07	1E-08		
Percent of Total		28	71	<1		
			Total Cancer Risk:		**1E-06**	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Dieldrin	0.12	1E-03	3E-03	NC	4E-03	8
Fluoranthene	0.65	8E-06	2E-05	NC	3E-05	<1
p,p-DDT	0.035	3E-05	9E-05	NC	1E-04	<1
Pyrene	0.6	1E-05	3E-05	NC	4E-05	<1
Cadmium	0.734	4E-04	2E-04	NC	6E-04	1
Copper	63	NC	NC	NC	NC	NC
Mercury	0.8165	1E-03	4E-04	5E-05	2E-03	3
Selenium	1.44	1E-04	6E-06	NC	1E-04	<1
Thallium	7.265	4E-02	2E-03	NC	5E-02	87
Zinc	109.5	2E-04	3E-05	NC	2E-04	<1
Pathway Total		5E-02	6E-03	5E-05		
Percent of Total		89	11	<1		
			Total Hazard Index:		**5E-02**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

than that estimated for pesticides. A summary of the risk estimates and qualitative factors affecting these estimates is presented in Table 15-4.

15.4.2.6. The total hazard index for future Depot personnel was estimated to equal 0.05, indicating that health effects other than cancer are not expected. While the inhalation exposure pathway has not been fully accounted for due to the absence of inhalation reference doses for many of the COPCs, the exposure doses are in a range where adverse health effects are unlikely (see Section 15.4.3. regarding this issue; exposure doses are presented in Appendix K). The concentration of lead in blood was not estimated because it was not detected at elevated concentrations.

15.4.2.7. Potential Future Construction Worker. The excess lifetime cancer risk for potential future construction workers was estimated to equal 9×10^{-8} (Table 15-5). Most of the calculated risk is generated by ingestion and dermal exposure to dieldrin. The potential to substantially underestimate the total cancer risk is low. While the dermal absorption of pesticides could be underestimated, even the assumption of 100 percent absorption only leads to a cancer risk of 1×10^{-6}.

15.4.2.8. The total hazard index was estimated to equal 0.04. While the hazard index does not include the inhalation pathway for most of the COPCs due to the absence of inhalation reference doses, the inhalation pathway is not expected to be significant for the reasons described for the Depot worker.

15.4.2.9. Potential Future TEAD-N Resident. For SWMU 48, the cancer risk from all exposure pathways was estimated to equal 5×10^{-4}, and the hazard index was estimated to equal 5. As shown on Table 15-6, the excess lifetime cancer risk for potential future residents exposed to soil at SWMU 48 was estimated to equal 6×10^{-6}. Most of the calculated cancer risk is from ingestion of arsenic and ingestion and dermal exposure to dieldrin. The significance of these risk estimates is diminished because it is unlikely that a home will be built at the location of this SWMU. If a home is built, most of the contaminated soil will probably be covered by pavement or grass (with the exception of garden areas). Because of the likely overestimates of the exposure point concentration and the ingestion rate, it is likely that a more realistic estimate of the potential cancer risk is less than 1×10^{-6} (see Section 15.4.3.).

15.4.2.10. The total hazard index for potential future child residents exposed to soil was estimated to equal 1. The majority of the hazard index is derived from the ingestion of

TABLE 15-4

TEAD-N BASELINE RISK ASSESSMENT
SWMU 48: OLD DISPENSARY DISCHARGE - BUILDING 400

Pathway	Likelihood of Completion	Uncertainty in Exposure Parameters and Bias	Hazard Index	Cancer Risk	95th Percentile Blood Lead Concentration (μg/dl)	Key Chemicals[a]
Depot Personnel					NC	
Ingestion	Future moderate	Medium-High/High	0.05	3×10^{-7}		Dieldrin, thallium
Dermal	Future moderate	High/Neutral-High	0.006	9×10^{-7}		
Inhalation	Future moderate	High/High	0.00005	1×10^{-8}		
Construction Worker					NC	
Ingestion	Future moderate	Medium-High/High	0.03	6×10^{-8}		Arsenic, thallium, mercury
Dermal	Future moderate	High/Neutral-High	0.003	3×10^{-8}		
Inhalation	Future moderate	Medium-High/High	0.0008	8×10^{-9}		
TEAD-N Resident					NC	
Ingestion	Future unlikely	Medium-High/High	1	3×10^{-6}		Dieldrin, thallium
Dermal	Future unlikely	High/Neutral-High	0.02	3×10^{-6}		
Inhalation	Future unlikely	High/High	0.0003	3×10^{-8}		
Vegetable Crops	Future unlikely	High/Neutral	4	5×10^{-4}		
Beef	Future/ unlikely	High/Neutral	0.00002	5×10^{-12}		

NC Not calculated
TEAD-N Tooele Army Depot North Area

(a) Chemicals that contribute 10 percent or more to total carcinogenic risk or hazard index

TABLE 15-5

SWMU 48 - OLD DISPENSARY DISCHARGE BUILDING 400
RME CANCER RISK AND HAZARD INDEX
FOR CONSTRUCTION WORKER

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion	Cancer Risk Dermal	Cancer Risk Inhalation	Chemical Cancer Risk	Chemical Percent of Total CR
Carcinogenic PAHs	0.005	1E-09	7E-10	NC	2E-09	2
Dieldrin	0.10	5E-08	3E-08	2E-09	9E-08	91
DDD	0.008	7E-11	4E-11	NC	1E-10	<1
DDE	0.009	1E-10	3E-11	NC	1E-10	<1
DDT	0.030	3E-10	2E-10	1E-11	5E-10	<1
Cadmium	0.67	NC	NC	6E-09	6E-09	6
Pathway Total		6E-08	3E-08	8E-09		
Percent of Total		59	32	9		
			Total Cancer Risk:		**9E-08**	

Hazard Index

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion	Hazard Index Dermal	Hazard Index Inhalation	Chemical Hazard Index	Chemical Percent of Total HI
Dieldrin	0.10	5E-03	3E-03	NC	7E-03	20
Fluoranthene	0.55	3E-06	2E-06	NC	5E-06	<1
DDD	0.01	NC	NC	NC	NC	NC
DDE	0.01	NC	NC	NC	NC	NC
DDT	0.03	1E-04	8E-05	NC	2E-04	<1
Pyrene	0.51	4E-06	2E-06	NC	6E-06	<1
Cadmium	0.67	2E-03	2E-04	NC	2E-03	5
Copper	54	NC	NC	NC	NC	NC
Mercury	0.69	5E-03	3E-04	8E-04	6E-03	18
Selenium	1.4	7E-04	6E-06	NC	7E-04	2
Thallium	6.6	2E-02	2E-04	NC	2E-02	53
Zinc	96	8E-04	2E-05	NC	8E-04	2
Pathway Total		3E-02	3E-03	8E-04		
Percent of Total		89	9	2		
			Total Hazard Index:		**4E-02**	

CR Cancer risk
HI Hazard index
NA Not applicable
NC Not calculated
RME Reasonable maximum exposure

TABLE 15-6

**SWMU 48 - OLD DISPENSARY DISCHARGE BUILDING 400
RME CANCER RISK, HAZARD INDEX, AND BLOOD LEAD CONCENTRATION
FOR FUTURE TEAD-N RESIDENT**

Cancer Risk

Chemical	Exposure Point Concentration (mg/kg)	Cancer Risk Ingestion Soil	Cancer Risk Dermal Soil	Cancer Risk Inhalation Soil	Cancer Risk Ingestion Produce	Cancer Risk Ingestion Beef	Chemical Cancer Risk	Chemical Percent of Total CR
Carcinogenic PAHs	0.0053	6E-08	5E-08	NC	1E-06	1E-12	1E-06	<1
Dieldrin	0.12	3E-06	2E-06	1E-08	5E-04	2E-12	5E-04	100
p,p'-DDD	0.009	3E-09	3E-09	NC	5E-08	1E-13	6E-08	<1
p,p'-DDE	0.01	5E-09	2E-09	NC	3E-08	9E-13	3E-08	<1
p,p'-DDT	0.035	2E-08	2E-08	6E-11	3E-07	5E-13	3E-07	<1
Cadmium	0.73	NC	NC	2E-08	NC	NC	2E-08	<1
Pathway Total		3E-06	3E-06	3E-08	5E-04	5E-12		
Percent of Total		<1	<1	<1	99	<1		
					Total Cancer Risk:		**5E-04**	

Hazard Index (Child)

Chemical	Exposure Point Concentration (mg/kg)	Hazard Index Ingestion Soil	Hazard Index Dermal Soil	Hazard Index Inhalation Soil	Hazard Index Ingestion Produce	Hazard Index Ingestion Beef	Chemical Hazard Index	Chemical Percent of Total HI
Dieldrin	0.12	3E-02	1E-02	NC	4E+00	2E-08	4E+00	68
Fluoranthene	0.65	2E-04	8E-05	NC	1E-02	3E-10	1E-02	<1
p,p'-DDD	0.009	NC	NC	NC	NC	NC	NC	NC
p,p'-DDE	0.01	NC	NC	NC	NC	NC	NC	NC
p,p'-DDT	0.035	9E-04	4E-04	NC	9E-03	2E-08	1E-02	<1
Pyrene	0.6	3E-04	1E-04	NC	1E-02	4E-10	1E-02	<1
Cadmium	0.73	9E-03	9E-04	NC	2E-01	2E-09	2E-01	4
Copper	63	NC	NC	NC	NC	NC	NC	NC
Mercury	0.82	3E-02	2E-03	3E-04	1E-01	8E-09	1E-01	3
Selenium	1.4	4E-03	3E-05	NC	NC	NC	4E-03	<1
Thallium	7.3	1E+00	8E-03	NC	2E-01	2E-05	1E+00	25
Zinc	110	5E-03	1E-04	NC	NC	2E-07	5E-03	<1
Pathway Total		1E+00	2E-02	3E-04	4E+00	2E-05		
Percent of Total		23	<1	<1	76	<1		
					Total Hazard Index:		**5E+00**	

CR	Cancer risk
HI	Hazard index
NA	Not applicable
NC	Not calculated
RME	Reasonable maximum exposure
TEAD-N	Tooele Army Depot North Area

thallium. However, thallium may be present at background concentrations rather than as a contaminant. Thallium was detected with a maximum concentration in surface soil of 7.3 mg/kg. While the background threshold for thallium is 6.6 mg/kg for this area of the Depot, other areas of the Depot have a background threshold greater than 7.3 mg/kg.

15.4.2.11. The significance of the hazard index from potential exposure to soil is also reduced because the exposure doses are probably overestimated. Likely overestimates include exposure point concentrations, the exposure frequency, and the soil ingestion rate. The absence of inhalation reference doses is unlikely to be a major omission due to the low probability of generating significant levels of dust in a residential setting. Consequently, the hazard index is probably less than 1. In summary, while the calculated cancer risk and hazard index from potential exposure to soil exceed their respective benchmarks in a residential setting, this is believed to be due to the conservativeness of the exposure parameters selected and the use of worst case data rather than representing a potential for an actual public health threat.

15.4.2.12. Exposure Through Vegetable Crops. For potential future residents ingesting produce grown at SWMU 48, the estimated cancer risk is 5×10^{-4} and the hazard index is 4 (Table 15-6), primarily due to dieldrin. This scenario primarily applies to residents that grow large quantities of vegetables for their own use, and has a high degree of uncertainty because of uncertainties in the plant uptake factors (see Section 15.4.3.).

15.4.2.13. Exposure Through Beef. For potential future residents ingesting beef from cattle grazing at SWMU 48, the estimated cancer risk is 5×10^{-12} and the hazard index is 0.00002 (Table 15-6). This scenario primarily applies to ranchers that may slaughter cattle for their own use, or people that purchase large quantities of beef from these ranchers. People will obtain only a minimal amount of beef from cattle grazing at SWMU 48 if they purchase their meat at a market, and their exposure will consequently be much lower. While this pathway was evaluated for all COPCs for which animal uptake data were available, the uptake of COPCs into beef is expected to be a major environmental fate mechanism only for COPCs that are present at elevated concentrations over a wide area. Cattle will be exposed infrequently to COPCs that are present at elevated concentrations over a small area. This exposure scenario has a high degree of uncertainty because of uncertainties in the plant and animal uptake factors.

15.4.3. Uncertainties

15.4.3.1. The exposure estimates and toxicity values have associated uncertainties, the magnitude and nature of which affect the degree of confidence in the results. Most of the uncertainties are such that risk estimates could be lower, but are unlikely to be higher than estimated. The following paragraphs discuss uncertainties related to exposure point concentrations and toxicity values, and are applicable to all receptors and pathways. These paragraphs are followed by discussions specific to each receptor. These discussions are focused on elements contributing the most to overestimates of the total risk, and on those elements where risks may be underestimates. Uncertainties in the toxicity values were discussed in conjunction with risk characterization in order to focus that discussion on those compounds contributing the most risk.

15.4.3.2. Sampling at SWMU 48 was from locations believed to represent areas with the highest concentrations of COPCs. Consequently, the exposure point concentrations are upper bound (worst case) estimates, and the exposure point concentrations should, therefore, be higher than the average concentrations of the contaminants.

15.4.3.3. Mixtures of chemicals were assumed to have a risk equal to the sum of the individual chemicals. While chemical mixtures have not been widely studied, it has been documented that they can in some cases be synergistic (the toxicity of the mixture is equivalent to the multiplicative toxicities of the individual components) or antagonistic (less toxic than the sum of the toxicity of the individual chemicals), as opposed to having additive toxicities. In addition, the assumption that hazard quotients are additive for chemicals with differing target organs and mechanisms of action is likely to be conservative, although exceptions to this assumption have been identified.

15.4.3.4. As was noted in the discussions of risk characterization, several of the compounds do not have inhalation reference doses. Metals can be much more toxic by inhalation than ingestion and, consequently, the absence of inhalation reference doses has the potential to overlook toxic effects. The potential for health effects for metals without inhalation reference doses has been qualitatively evaluated by examining the inhalation exposure doses. An inspection of IRIS and HEAST shows that there is only one chemical with a reference dose below 1×10^{-6} mg/kg/day, thus this could be used as a conservative (verging on worst-case) default reference dose. Since a hazard quotient is calculated by dividing the exposure dose by the reference dose, exposure doses below 1×10^{-6} have been assumed to have little potential for toxic effects. The potential for toxic

effects via inhalation of metals with exposure doses greater than 1 x 10^{-6} were examined on a case-by-case basis. The results of this evaluation were presented in Section 15.4.2. Exposure doses are summarized in Appendix K.

15.4.3.5. Depot Worker. One factor affecting the cancer risk estimates for the Depot worker is the assumption that exposure will take place over a 25-year period. Most people change jobs, or their job location, more frequently. The resulting cancer risk would be reduced according to how long a person is actually at the contaminated job location.

15.4.3.6. The greatest uncertainty related to inhalation exposure is the assumed dust level of 50 $\mu g/m^3$, which is the National Ambient Air Quality Standard for respirable dust. Because SWMU 48 is small and mostly vegetated, only a small fraction of the dust will originate within the SWMU, and using a value of 50 $\mu g/m^3$ will overestimate the resulting inhalation exposure.

15.4.3.7. Uncertainties related to ingestion exposure derive primarily from the soil ingestion rate. A typical ingestion rate for adults is probably closer to 25 mg/day (DTSC, 1992), rather than the 50 mg/day assumed in this risk assessment. Also, while soil contaminants were assumed to be 100 percent bioavailable, the actual bioavailability may be substantially less. Dermal exposure uncertainties are associated with the amount of skin covered with soil and the fraction of contaminant absorbed through the skin. While estimates of the area of exposed skin are fairly realistic, it is likely that less than 100 percent of the exposed skin would be covered with soil. Consequently, the assumed area of skin exposed will be an overestimate. Recent EPA research has indicated that the soil adherence factor of 1 mg/cm^2 is applicable only to the front of the hands (i.e., the palms); an adherence factor of 0.2 mg/m^3 is applicable to the rest of the body. Consequently, while dermal absorption could be higher than estimated, the overall dermal dose could still be much lower than estimated.

15.4.3.8. Construction Worker. Uncertainties associated with the exposure dose for a construction worker are high. As in the case of the Depot worker, uncertainties associated with estimates of dermal exposure include amount of skin covered with soil and the fraction of contaminant absorbed through the skin. Ingestion uncertainties are greater for the construction worker than for the Depot worker. As discussed in relation to SWMU 1 (Section 5.4.3.), ingestion rates are likely to be at least a factor of 3.5 less than

what was assumed in this BRA. If the bioavailability of COPCs is less than 100 percent, then ingestion exposure will be further reduced compared to the estimated dose.

15.4.3.9. Similar to the Depot worker, uncertainties related to inhalation exposure are primarily associated with the dust concentration. The amount of wind-generated dust from SWMU 48 is expected to be low based on the small size of this SWMU and the fact that it is mostly paved. Unless a construction project generates dust levels on the order of 1 mg/m^3, typical dust levels would probably be one or more orders of magnitude less than the 1 mg/m^3 assumed in this BRA.

15.4.3.10. TEAD-N Residents. The uncertainties for construction and Depot workers are also applicable to in the evaluation of future residents at TEAD-N, although the magnitudes of the uncertainties differ. In a residential setting, most soil is normally covered with pavement or grass, which greatly reduces the potential for inhalation exposure, and (to a lesser extent) reduces the potential for dermal and ingestion exposure. As in the case of the workers, uncertainties associated with the inhalation exposure estimates for a resident are primarily associated with the dust level. The EPA default ingestion rates used in this BRA are thought to be overestimates for adults and most children, but pica children (i.e., children who directly eat soil) consume unusually large amounts of soil. Consequently, there is a small percentage of children whose ingestion rate exceeds the assumed rate of 200 mg/day. For dermal exposure, young children may cover their exposed skin with soil more completely than adults. The assumed skin surface area is probably more reasonable for this age group than for adults.

15.4.3.11. The greatest uncertainties with respect to exposure from ingestion of produce and beef relate to uptake factors from soil to vegetables or forage, and from forage or incidentally ingested soil to beef. The exposure assessment assumed that there was a constant ratio of the contaminant concentration in the vegetables and forage versus the concentration in the surrounding soil. However, there are data indicating that plant uptake of chemicals is dependent upon factors such as soil pH, contaminant concentration, soil type, and even the season of the year (Alloway, 1990).

15.4.3.12. The plant uptake models are based on theoretical predictions with minimal validation. The plant uptake factors for organic compounds are based solely on a regression from the compounds' octanol-water partition coefficients (log K_{ow}). Data used to develop the uptake regression relationship between the log K_{ow} and the plant uptake factor often had actual uptake factors that varied from the predicted values by 1 to 2

orders of magnitude, and the regression only had an r^2 value of 0.53. Similarly, there are also large uncertainties in evaluating the uptake of COPCs from forage or incidentally ingested soil to beef.

15.4.4. Recommendations

15.4.4.1. Based on the preceding discussions, the following recommendations are made:

- Allow unrestricted use of this site as long as it remains part of the depot
- Evaluate the need for institutional controls and/or corrective action in a Corrective Measures Study should this land no longer be controlled by the depot.

15.5 ECOLOGICAL RISK ASSESSMENT

15.5.0.1. The conceptual site model showing the mechanism by which a chemical is released from a source, the transport mechanism, and the exposure routes to the different ecological receptors is presented in Figure 3-3. The different trophic levels in the ecological community at TEAD-N are presented in Figure 3-4. Because less data are available for this SWMU than the other Group A SWMUs, it is being evaluated at a screening level only with the purpose of deciding whether there is cause to further investigate this site.

15.5.1. Ecological Receptors.

15.5.1.1. The area within SWMU 48 was not included in the biological survey done at the TEAD-N facility. Based on a cursory inspection of the site, the site of the previous TEAD-N Dispensary is a grass-covered area. The sampling points are located at the outfalls of two stormwater lines which actually extend beyond the site area. The mapped soil and range type are:

Range Site: Semi-Desert Gravelly Loam
Soil Types: Hiko Peak gravelly loam with 2-15 percent slopes

The range site describes the climax vegetation expected to occur at each site due to the combined influence of environmental factors characteristic for the site. In this range site

Wyoming Big Sagebrush is the dominant, and most conspicuous, plant species identified. Other dominant plant species expected in the semi-desert gravelly loam range site near this SWMU are bluebunch wheatgrass, Indian ricegrass, Douglas rabbitbrush, bottlebrush squirreltail, and Hood phlox (SCS, 1992).

15.5.1.2. As stated previously, no biological surveys were conducted at this site. It is reasonable to assume, however, that the wildlife at the site will be similar to what has been observed at other sites in the same general area. This ecological assessment has been performed with the assumption that the wildlife receptors are not limited by the physical boundaries of each SWMU; therefore, the spatial distribution of the detected chemicals at SWMU 48 is assumed to potentially expose the wildlife species that occur or that may potentially occur at the TEAD-N facility as a whole.

15.5.2. Exposure Analysis

15.5.2.1. The potential exposure pathway at SWMU 48 is primarily via soil. SWMU 48 contains no surface water; thus, the surface water exposure pathway is incomplete and is excluded from the ecological assessment. Direct exposure occurs when a receptor comes into direct contact with a chemical, such as a mouse burrowing in contaminated soil, and indirect exposure occurs via the food web, such as when a raptor consumes the mouse. The direct exposure pathways at SWMU 48 are soil ingestion and dermal exposure. Indirect exposure occurs through the ingestion of contaminated prey through food web pathways.

15.5.2.2. Small mammals are predominantly exposed via direct pathways (ingestion of soil) and, to a lesser extent, via food web pathways (ingestion of contaminated plants). As prey, they may also expose predators.

15.5.2.3. Antelope and deer (herbivores) are exposed predominantly via direct pathways (ingestion of soil while grazing) and as prey, may expose predators. The coyote (a predator) is exposed predominantly via food web pathways, unless their den is located in contaminated soil, in which case there would be direct exposure. The predominant route of exposure for the raptors is via food web pathways. Birds are exposed via food web pathways by ingestion of seeds, grasses, and by direct exposure to soil during preening.

15.5.3. Risk Characterization

15.5.3.1. The ecological risk characterization for the COPECs at SWMU 48 is based on the ecological toxicity quotient (ETQ) based on the dose, via ingestion, to the keystone species discussed in the methodology. The ingestion pathway is the most significant exposure pathway, therefore, the assessment is based on the worst case scenario. Mercury, although above the background soil concentrations, cannot be evaluated further due to a scarcity of available ecotoxicological values. Among the PAHs, ecotoxicological values are available only for fluoranthene. The ETQ of fluoranthene is less than one. The concentrations of the other PAHs were the same as or less than fluoranthene. A reasonable assumption is that the other PAHs have a similar ecotoxicity as fluoranthene and, if so, the other PAHs would have ETQs less than one. A similar result was obtained when DDT was evaluated as the representative analyte for the pesticides. Assuming that DDD, DDE, and dieldrin have similar ecological toxicity as DDT, these compounds are also present at concentrations below what is expected to cause toxic effects in the environment. Based on the results of the qualitative evaluation, there is no evidence that pesticides or PAHs are present in concentrations that could cause adverse effects in the environment. Because of the lack of terrestrial ecotoxicity data for mercury, no evaluation can be made for this metal. However, because of the small area affected by SWMU 48 and the lack of a native environment, no further ecological investigation is deemed necessary.

15.5.4. Recommendations

15.5.4.1. Based on the preceding discussions, SWMU 48 is recommended for no further investigation regarding potential ecological effects.

16.0 PROTECTION STANDARDS

16.1 INTRODUCTION

16.1.0.1. As part of TEAD's Correction Action Permit, certain Protection Standards (PS) criteria have been established. The Protection Standards require that remedial actions must attain clean-up thresholds that assure protection of human health and the environment. In addition, remedial actions that leave any hazardous substances, pollutants, or contaminants on-site must, upon completion, meet a level or standard that, at the least, attains legally applicable or relevant and appropriate requirements. RCRA sets requirements for compliance with the Protection Standards, and also requires attainment of state Protection Standards if they are more stringent than federal Protection Standards, legally enforceable, and consistently enforced statewide.

16.1.0.2. A Protection Standard may be either "applicable" or "relevant and appropriate," but not both. According to the NCP (40 Code of Federal Regulations [CFR] Part 300), "applicable" or "relevant and appropriate" are defined as follows:

- "**Applicable requirements** are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminants, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable."

- "**Relevant and appropriate requirements** are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate."

16.1.0.3. There is little discretion involved in the determination of an applicable requirement. If the requirement is not applicable, the decision-maker's best professional judgment is used to determine whether the requirement is relevant and appropriate. However, once a regulation is identified as relevant and appropriate, it is applied as strictly as is an applicable requirement.

16.1.0.4. Protection Standards are identified on a site-specific basis. Neither SARA nor the NCP provides across-the-board standards for determining whether a particular remedy will adequately clean up a particular site. Rather, the process recognizes that each site will have unique characteristics that must be evaluated and compared to those requirements that apply under the given circumstances.

16.2 SUMMARY OF PROTECTION STANDARDS FOR TEAD-N

16.2.0.1. There are three types of Protection Standards: chemical-specific, action-specific, and location-specific. The following paragraphs discuss each of these types of Protection Standards and identifies the Protection Standards that are applicable or relevant and appropriate to TEAD-N.

16.2.0.2. Chemical-Specific Protection Standards. Chemical-specific Protection Standards are usually health or risk-based numerical values that establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to the ambient environment. Table 16-1 provides a summary of the federal and state chemical-specific Protection Standards that may be "applicable" or "relevant and appropriate" to the Group A SWMUs at TEAD-N.

16.2.0.3. Action-Specific Protection Standards. Action-specific Protection Standards are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes, or requirements to conduct certain actions to address particular circumstances at a site. For example, remedial alternatives that involve discharge of dredged or fill material may be subject to Protection Standards relating to RCRA and the Clean Water Act. Determining action-specific Protection Standards depends on the chosen remedial activity at a given site (or SWMU). A comprehensive overview of action-specific Protection Standards that may be applicable or relevant and appropriate to the TEAD-N Group A SWMUs are presented in Table 16-2. The list of potential action-specific Protection Standards will be evaluated further as remedial technologies are actually chosen for each SWMU under investigation.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
<u>FEDERAL</u>				
Safe Drinking Water Act	42 USC § 300			
National Primary Drinking Water Standards	40 CFR Part 141	Establishes health-based standards for public water systems and specifies maximum contaminant levels (MCLs).	No/Yes	No evidence of surface water or groundwater contamination at Group A SWMUs.
National Secondary Drinking Water Standards	40 CFR Part 143	Establishes welfare-based standards for public water systems and specifies secondary maximum contaminant levels (SMCLs).	No/Yes	No evidence of surface water or groundwater contamination at Group A SWMUs.
Maximum Contaminant Level Goals (MCLGs)	40 CFR Part 141	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety.	No/Yes	No evidence of surface water or groundwater contamination at Group A SWMUs.
Clean Water Act	33 USC §§ 1251-1376			
Ambient Water Quality Criteria	40 CFR Part 131	Establishes criteria for water quality based on toxicity to aquatic organisms.	No/Yes	Any proposed remedial actions will not involve point source discharges into U.S. waters.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Effluent Guidelines and Standards for the Point Source Category	40 CFR Part 414	Requires specific effluent discharge characteristics for discharge under NPDES permits.	No/Yes	Any proposed remedial actions will be in compliance with regulations.
National Pretreatment	40 CFR Part 403	Sets standards to control pollutants which pass through or interfere with treatment processes in publicly owned treatment works or which may contaminate sewage sludge.	No/Yes	Any proposed remedial actions will be in compliance with regulations.
Toxic Pollutant Effluent Standards	40 CFR Part 129	Establishes effluent standards or prohibitions for certain toxic pollutants.	No/Yes	Any proposed remedial actions will be in compliance with regulations.
Water Quality Standards	40 CFR Part 131	Sets criteria for water quality based on toxicity to human health.	Yes/--	Any proposed remedial actions will be in compliance with regulations.
Ambient Water Quality Criteria	40 CFR Part 131 Subpart D	Sets criteria for ambient water quality based on toxicity to aquatic organisms.	Yes/--	Any proposed remedial actions will be in compliance with regulations.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
FEDERAL				
Safe Drinking Water Act	42 USC § 300			
National Primary Drinking Water Standards	40 CFR Part 141	Establishes health-based standards for public water systems and specifies maximum contaminant levels (MCLs).	No/Yes	No evidence of surface water or groundwater contamination at Group A SWMUs.
National Secondary Drinking Water Standards	40 CFR Part 143	Establishes welfare-based standards for public water systems and specifies secondary maximum contaminant levels (SMCLs).	No/Yes	No evidence of surface water or groundwater contamination at Group A SWMUs.
Maximum Contaminant Level Goals (MCLGs)	40 CFR Part 141	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety.	No/Yes	No evidence of surface water or groundwater contamination at Group A SWMUs.
Clean Water Act	33 USC §§ 1251-1376			
Ambient Water Quality Criteria	40 CFR Part 131	Establishes criteria for water quality based on toxicity to aquatic organisms.	No/Yes	Any proposed remedial actions will not involve point source discharges into U.S. waters.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Effluent Guidelines and Standards for the Point Source Category	40 CFR Part 414	Requires specific effluent discharge characteristics for discharge under NPDES permits.	No/Yes	Any proposed remedial actions will be in compliance with regulations.
National Pretreatment	40 CFR Part 403	Sets standards to control pollutants which pass through or interfere with treatment processes in publicly owned treatment works or which may contaminate sewage sludge.	No/Yes	Any proposed remedial actions will be in compliance with regulations.
Toxic Pollutant Effluent Standards	40 CFR Part 129	Establishes effluent standards or prohibitions for certain toxic pollutants.	No/Yes	Any proposed remedial actions will be in compliance with regulations.
Water Quality Standards	40 CFR Part 131	Sets criteria for water quality based on toxicity to human health.	Yes/--	Any proposed remedial actions will be in compliance with regulations.
Ambient Water Quality Criteria	40 CFR Part 131 Subpart D	Sets criteria for ambient water quality based on toxicity to aquatic organisms.	Yes/--	Any proposed remedial actions will be in compliance with regulations.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Solid Waste Disposal Act	42 USC §§ 6901-6987			
Criteria for the Identification and Listing of Hazardous Waste	40 CFR Part 261	Establishes solid wastes that are subject to regulation as hazardous waste under 40 CFR Parts 124, 262-265, 268, and 270.	Yes/--	Wastes generated during the remediation phase which are determined to contain RCRA hazardous constituents, will be subject to these requirements.
Groundwater Protection	40 CFR Part 264.90-264.101	Establishes standards for pollutants that will, or are likely to enter into groundwater.	Yes/--	Any proposed remedial action will maintain groundwater standards in compliance with regulations.
Requirements for Releases from Solid Waste Management Units	40 CFR Part 264, Subpart F	Establishes maximum concentrations for hazardous constituents in the groundwater.	No/Yes	The groundwater cleanup standards may be based on these maximum concentrations if they are more stringent than MCLs or non-zero MCLGs, or if no standards exist.
Land Disposal Restrictions	40 CFR Part 268	Establishes maximum concentrations for hazardous constituents prior to land disposal.	Yes/--	Any hazardous wastes generated during the remediation phases will be subject to land disposal restrictions and may be required to meet BDAT technologies and/or constituent concentrations.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Clean Air Act	42 USC § 7401			
National Ambient Air Quality Standards	40 CFR Part 50	Establishes primary and secondary standards for six pollutants: PM_{10}, SO_2, CO, ozone, NO_2, and lead.	Yes/--	Emissions from the remediation process will be subject to the National Ambient Air Quality Standards.
National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61 Subpart A	Sets emission standards for designated hazardous pollutants.	Yes/---	Air emissions from any remediation process will be subject to these requirements.
Resource Conservation and Recovery Act	Section 3004(m)	Waives prohibition of land disposal of a particular hazardous waste if levels or methods of treatment substantially reduce toxicity or likelihood of migration of hazardous constituents to minimize short and long-term threats to human health and the environment.	Yes/--	Applicable if remedial alternatives involve landfilling of contaminated soil.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
STATE				
Utah Safe Drinking Water Act				
Utah Primary drinking Water Standards	R309-103-1 UAC	Establishes maximum contaminant levels (MCLs) for inorganic and organic chemicals as primary drinking water standards.	No/Yes	No evidence of surface water or groundwater contamination at Group A SWMUs. Some MCLs established for contaminants are not federally regulated (e.g., total dissolved solids).
Utah Groundwater Protection Rules	R317-6 UAC	Establishes standards for pollutants that will, or are likely to enter into groundwater	Yes/--	Any proposed remedial actions must assure that groundwater will be protected.
Utah Secondary Drinking Water Standards	R309-103-2 UAC	Establishes maximum contaminant levels for inorganic and organic chemicals as secondary drinking water standards.	No/Yes	Requirements may be relevant and appropriate for groundwater protection. However, no evidence of surface water or groundwater contamination at Group A SWMUs.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS
(CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Utah Solid and Hazardous Waste Act	Title 19 UAC Chapter 6*			
Land Disposal Restrictions (LDRs)	R315-13 UAC	Outlines land disposal restrictions for hazardous waste. Utah incorporates federal LDRs by reference.	Yes/--	Hazardous wastes generated during remediation will be subject to land disposal restrictions and may be required to meet BDAT technologies and/or constituent concentrations.
Criteria for the Identification and Listing of Hazardous Waste	R315-2-1 UAC	Establishes solid wastes that are regulated as hazardous wastes under the Utah Solid and Hazardous Waste Act. Definition of hazardous waste mirrors federal definition.	Yes/--	If wastes generated during the remediation phase are determined to contain hazardous constituents, they will be subject to these requirements.
Corrective Action Cleanup Standards	R315-101 UAC	Corrective action clean-up standards policy - RCRA, UST, and CERCLA sites.	No/Yes	Lists general criteria to be considered in establishing clean-up standards. Refer to Safe Drinking Water Act and Clean Air Act. Requires removal or control of the source.

TABLE 16-1

IDENTIFICATION OF CHEMICAL-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Utah Air Conservation Act	Title 26 UCA Chapter 13			
Standards for the Control of Installations	R307-1-3 UAC	Specifies standards for six pollutants: PM_{10}, SO_2, CO, ozone, NO_2, and lead. State adoption of federal --AQS and BACT.	Yes/--	Emissions from the remediation process will be subject to the standards for the six pollutants.

Yes/-- Because a Protection Standard is applicable it cannot be relevant and appropriate and is designated as --.
--AQS National Ambient Air Quality Standards
BACT Best Available Control Technology
NESHAPs National Emission Standards for Hazardous air Pollutants
NSPS New Source Performance Standards

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
FEDERAL				
Solid Waste Disposal Act	42 USC §§ 6901-6987			
Guidelines for the Land Disposal of Solid Wastes	40 CFR Part 241	Establishes requirements and procedures for land disposal of solid wastes	Yes/--	Potential action-specific ARAR. Applicable to any remedial action that may involve landfill storage of non-hazardous contaminated soils or debris. Not applicable or relevant and appropriate for hazardous soils.
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment.	Yes/--	Applicable any remedial actions involving off-site landfilling of contaminated soils.
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Establishes requirements for generators of hazardous waste.	Yes/--	Any proposed remedial actions will be in compliance with regulations.
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Establishes requirements for transporters of hazardous waste.	Yes/--	Possible remediation strategies may include the transportation of hazardous waste.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
General Facility Standards	40 CFR Part 264, Subpart B	Establishes general facility management standards for hazardous waste treatment, storage, and/or disposal facilities.	Yes/--	Facility management plans may be developed, as needed, to implement other 40 CFR Part 264 requirements.
Standards of Preparedness and Prevention	40 CFR Part 264, Subpart C	Establishes requirements for preparedness and prevention at hazardous waste treatment, storage, and/or disposal facilities.	Yes/--	Preparedness and prevention measures may be developed, as needed, to implement other 40 CFR Part 264 requirements.
Contingency Plan and Emergency Procedures	40 CFR Part 264, Subpart D	Establishes requirements for a contingency plan and emergency procedures at hazardous waste treatment, storage, and/or disposal facilities.	Yes/--	A contingency plan and emergency procedures may be developed, as needed, to implement other 40 CFR Part 264 requirements.
Manifest System, Recordkeeping, and Reporting Requirements	40 CFR Part 264, Subpart E	Establishes requirements for the manifest system as well as for recordkeeping and reporting at hazardous waste treatment, storage, and/or disposal facilities.	Yes/--	Not a substantive requirement. Requirements for the manifest system, recordkeeping, and reporting may be developed, as needed, to implement other 40 CFR Part 264 requirements.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Requirements for Releases From Solid Waste Management Units	40 CFR Part 264, Subpart F	Establishes requirements for detection and containment of releases from waste management units at hazardous waste treatment, storage, and/or disposal facilities.	Yes/--	If any remedial actions involve capping/containment and/or continued groundwater monitoring, groundwater monitoring requirements will be applicable.
Closure and Post-Closure Standards	40 CFR Part 264, Subpart G	Establishes general standards for closure and, if required, post-closure at hazardous waste treatment, storage, and/or disposal facilities.	Yes/--	Closure and, if required, post-closure will be needed for any hazardous waste management units.
Standards for the Use and Management of Containers	40 CFR Part 264, Subpart I	Establishes design and operational requirements for the use and management of containers containing hazardous waste.	Yes/--	Permanent storage of containers containing hazardous waste will not be part of the remediation strategy. However, all temporary storage and management of containers will be in accordance with the requirements of this subpart.
Standards for the use of Waste Piles during materials handling operations on site	40 CFR Part 264, Subpart L	Establishes design and operational requirements for the use and management of waste piles during materials handling operations on site.	No/Yes	Relevant and appropriate to materials handling operations on site.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Standards for the use of Land treatment remedial alternatives	40 CFR Part 264, Subpart M	Establishes design and operational requirements for the use and management of land treatment alternatives.	No/Yes	Relevant and appropriate if land treatment is considered a potential remedial action.
Standards for the use of Landfills for contaminant disposal	40 CFR Part 264, Subpart N	Establishes design and operational requirements for the use and management of landfills.	No/Yes	Relevant and appropriate if landfills will be used to dispose of contaminated soil.
Standards for Miscellaneous Units	40 CFR Part 264, Subpart X	Establishes design and operational requirements for miscellaneous hazardous waste management units.	Yes/--	If on-site treatment is performed as a part of the remedial action, the miscellaneous management unit will be designed and operated in accordance with the requirements of this subpart.
Air Emissions Standards	40 CFR Part 264, Subparts AA and BB	Establishes monitoring and recordkeeping requirements for process vents and equipment leaks.	No/Yes	Equipment will be monitored in accordance with the requirements of these subparts.
Land Disposal Restrictions	40 CFR Part 268	Establishes hazardous wastes that are restricted from land disposal and describes those circumstances where treated waste may be land disposed.	Yes/--	Hazardous wastes generated during remedial actions will be managed in accordance with the requirements of this part.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Hazardous Waste Permit Program	40 CFR Part 270	Establishes provisions covering basic EPA permitting requirements.	Yes/---	Applicable to disposal of hazardous waste to POTW (40 CFR 270.60[b,c])
Clean Water Act	33 USC §§ 1251-1376			
National Pollutant Discharge Elimination System	40 CFR Parts 122-125	Requires permits for the discharge of pollutants from any point source into waters of the United States.	Yes/---	Applicable to any remedial action that may involve discharge of treated water to a POTW.
Dredge or Fill Requirements	40 CFR Parts 230-231	Requires discharges to address impact of discharge, dredge, or fill material on the aquatic ecosystem.	No/Yes	Any proposed remedial actions will not involve dredge and fill of soil; however, grading, backfill, and/or excavation are possible remedial actions.
National Pretreatment Standards	40 CFR Part 403	Sets standards to control pollutants which pass through or interfere with treatment processes in publicly owned treatment works or which may contaminate sewage sludge.	Yes/---	Remediation strategies may include discharge to publicly-owned treatment works.
Occupational Safety and Health Act	29 USC §§ 651-678			
Excavation	29 CFR 1926 Subpart F	Establishes standards for excavation.	Yes/--	Any remedial action which may include excavation will be in compliance with regulations.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Worker Safety Standards	29 CFR Part 1910	Establishes standards for worker safety at hazardous waste facilities.	Yes/--	Worker safety requirements will be in accordance with the requirements of this part.
Hazardous Materials Transportation Act	49 USC §§ 1801-1813			
Hazardous Materials Transportation	49 CFR Parts 107 and 171-177	Establishes requirements for transportation of hazardous materials.	Yes/--	Transportation of hazardous materials off site will be in accordance with the requirements of these parts.
USACE Guidlines and Policies				
Department of Army Ammunition and Explosvies Saftey Documents	USAT CESP 385-02	UXO safety guidlines for explosives and ammunition.	Yes/--	Any proposed activities at SWMUs 1, 20, 21,37,42 and 45 will be in compliance with regulations.
Department of Army Ammunition and Explosvies Saftey Standards	AR 385-64	UXO safety guidlines for explosives and ammunition.	Yes/--	Any proposed activities at SWMUs 1, 20, 21,37,42 and 45 will be in compliance with regulations.
Department of Army Ammunition and Explosvies Saftey Directive	#6055.9	UXO safety guidlines for explosives and ammunition.	Yes/--	Any proposed activities at SWMUs 1, 20, 21,37,42 and 45 will be in compliance with regulations.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Resource Conservation and Recovery Act	Section 3020	Regulates reinjection of hazardous waste during remediation.	No/Yes	Any proposed remedial actions will not involve reinjection of hazardous waste.
STATE				
Utah Administrative Code	73-3-25			
State Engineer, Department of Natural Resources	R655-4 UAC	Establishes standards for drilling and abandonment of wells.	Yes/--	Remedial actions may include groundwater monitoring.
Utah Occupational Safety and Health Act	Title 35, UCA Chapter 9			
Worker Safety Standards	R574 UAC	Establishes occupational safety and health standards.	Yes/--	All remediation strategies will require worker safety procedures and practices. Rules mirror Federal OSHA regulations.
Utah Air Conservation Act	Title 26 UCA Chapter 13			
Definitions and General Requirements for Air Conservation	R307-1-1 R307-1-2 UAC	Outlines general requirements and provides definitions for Utah Air Conservation rules.	Yes/--	General requirements and definitions will be applicable for remediation strategies that include pollutant emissions.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Standards for the Control of Installations	R307-1-3 UAC	Establishes notification requirements, details operating limitations, and specifies criteria for AQS violations and PSD review.	Yes/--	Notification and reviews for --AQS violations and PSD will be required for remediation strategies that include pollutant emissions.
Emission Standards	R307-1-4 UAC	Establishes standards for particulate matter and opacity as well as fugitive emissions and VOCs in non-attainment areas. Rule also details unavoidable breakdown criteria, fugitive dust requirements, and State NESHAPs.	Yes/--	Remediation strategies that include pollutant emissions must meet particulate matter and opacity standards. Fugitive dust requirements must also be met.
Utah Solid and Hazardous Waste Act	Title 19 UAC Chapter 6[a]			
Definitions and General Requirements for Solid and Hazardous Waste	R315-1 R315-2 UAC	Outlines general requirements and provides definitions for Utah Solid and Hazardous Waste Regulations.	Yes/--	General requirements and definitions will be applicable for the management of solid and/or hazardous waste.
Hazardous Waste Manifest Requirements	R315-4 UAC	Details requirements for manifesting shipments of hazardous waste inside the state.	Yes/--	All shipment of hazardous waste will require manifests meeting State requirements.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Hazardous Waste Generator Requirements	R315-5 UAC	Outlines requirements for generators of hazardous waste.	Yes/--	Generator requirements will be applicable for all hazardous waste generated during remediation.
Hazardous Waste Transporter Requirements	R315-6 UAC	Outlines requirements for the transportation of hazardous waste.	Yes/--	Requirements will be applicable to remediation strategies which include transportation of hazardous waste to an off-site location
Requirements for Hazardous Waste Facilities	R315-8 UAC	Establishes general requirements for facility management and specific requirements for hazardous waste management units.	Yes/--	General facility management plans (R315-8-2 through R315-8-4) may be developed, as needed, to implement other requirements of R315. Standards for groundwater protection (R315-8-6); closure and post closure (R315-8-7); use and management of containers (R315-8-9); and tanks (R315-8-10) will be applicable depending on the remediation strategy.
Emergency Control Requirements	R315-9 UAC	Outlines the immediate action, cleanup, and reporting requirements for spills involving hazardous waste.	Yes/--	Emergency control requirements will be applicable if any hazardous waste spills occur during the remediation process.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Land Disposal Restrictions	R315-13 UAC	Outlines land disposal restrictions for hazardous waste. Utah incorporates federal LDRs by reference.	Yes/--	Hazardous wastes generated during remediation will be managed in accordance with the requirements of this rule.
Corrective Action Cleanup Standards Policy	R315-101 UAC	Specifies the State of Utah's policy for cleanup at RCRA, UST, and CERCLA sites.	Yes/--	Remedial actions must achieve compliance with the cleanup standards policy.
Utah Water Pollution Control Act	Title 26 UCA Chapter 11			
Definitions and General Requirements	R317-1 UAC	Details definitions and general requirements for water quality in Utah (including construction permits).	Yes/--	General requirements and definitions will be applicable for remedial actions including point source discharges.
Design Requirements for Wastewater Collection, Treatment, and Disposal Systems`	R317-3 UAC	Outlines design requirements for the collection, treatment, and disposal of domestic wastewater.	No/Yes	Treatment of domestic wastewater will not be part of any remedial actions.

TABLE 16-2

IDENTIFICATION OF ACTION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Groundwater Quality Protection Standards	R317-6 UAC	Details, standards, classes, protection levels, and implementation criteria for groundwater protection. Also, outlines certain activities permitted by rule.	Yes/--	Groundwater quality protection standards will be relevant for any remedial actions. If remedial actions discharge treated water to groundwater, discharge will be covered under a permit by rule (R317-6-6.2A.16).
Underground Injection Control	R317-7 UAC.	Establishes requirements for underground injection of water.	Yes/--	Applicable if treated water is injected.
Utah Pollutant Discharge Elimination System Requirements	R317-8 UAC	Establishes general requirements, definitions, permitting procedures, and criteria/standards for technology-based treatment for point source discharges of wastewater. Also establishes pretreatment standards for discharge to a POTW.	Yes/--	If any remedial action calls for a point source discharge of wastewater, UPDES requirements would be applicable. Pretreatment standards would be applicable if selected alternative involved discharge to a POTW.

-- Because the Protection Standard is applicable it cannot be relevant and appropriate (designated as --).

AQS	National Ambient Air Quality Standards	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
PSD	Prevention of significant deterioration	NESHAPs	National Emission Standards for Hazardous Air Pollutants
RCRA	Resource Conservation and Recovery Act	POTW	Publicly Owned Treatment Works
UST	Underground storage tanks		

16.2.0.4. Location-Specific Protection Standards. Location-specific Protection Standards generally are restrictions placed upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations. Some examples of special locations include flood plains, wetlands, historic places, and sensitive ecosystems or habitats. Table 16-3 provides a summary of potential federal and state location specific Protection Standards, along with comments on why the regulation is a Protection Standard for TEAD-N. This list may require further refinement as remedial technologies are actually chosen for each SWMU.

TABLE 16-3

IDENTIFICATION OF LOCATION-SPECIFIC PROTECTION STANDARDS

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
FEDERAL				
Standards for Owner and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities	40 CFR 264.18(a)	Portions of new facilities must not be within 61 meters (200 feet) of a fault which has had displacement in Holocene time.	Yes/--	May be relevant if remedial activities include construction of a TSD facility.
EPA Ground-Water Protection Strategy	EPA Guidance	Establishes a ground-water classification system for protection of ground waters based on their value to society, use, and vulnerability.	No/No	Contributes to the National Primary Drinking Water Standards (MCLs) being remedial action objectives. Contaminated groundwater is not suspected and/or has not been identified at any of the Group A SWMUs.
National Historic Preservation Act	16 USC Sec 470 40 CFR Sec. 6.301(B) 36 CFR Part 800	Requires Federal agencies to locate, inventory, and nominate properties of their control that are eligible for the National Register of Historic Places.	Yes/--	May be relevant if any such properties are identified at TEAD-N.
Executive Order on Protection and Enhancement of the Cultural Environment	Exec. Order #11,593	Establishes consultation procedures and responsibilities of Federal agencies for historic preservation.	No/Yes	Substantive requirements can be met through compliance with 36 CFR Part 800.
Historic Sites, Buildings, and Antiquities Act	16 USC Sec. 461-467 40 CFR Sec. 6.301(A)	Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	Yes/--	See comment above.
Archaeological Resources Protection Act of 1979	16 USC 470aa-11 43 CFR 7	Requires Federal agencies to identify and protect archaeological resources.	Yes/--	May be relevant if any such resources are identified at TEAD-N.
Archaeological and Historic Preservation Act	16 USC Sec. 469 40 CFR Sec. 6.301(C)	Establishes procedures to provide for preservation of historical and archaeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program.	Yes/--	See comment above.

TABLE 16-3

IDENTIFICATION OF LOCATION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Fish and Wildlife Coordination Act	16 USC Sec. 661-666 40 CFR Sec. 6.302(G)	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources.	Yes/--	May be relevant if remedial activities impact any wildlife, fish, other aquatic resources or habitats.
Clean Water Act	§404§			
Control Actions in National Wildlife Refuge System	16 USC Sec. 668d et seq 50 CFR Part 27	Only actions allowed under 16 USC Sec. 668dd(c) may be undertaken in areas that are part of the National Wildlife Refuge System.	No/No	A National Wildlife Refuge does not exist at TEAD-N.
Wilderness Act	16 USC Sec. 1131 et seq 50 CFR 35.1	Federally owned areas designated as wilderness areas must be left unimpaired as wilderness and to preserve its wilderness.	No/No	No wilderness area designated at TEAD-N.
Endangered Species Act	16 USC Sec. 1531-1543 50 CFR Part 200 50 CFR Part 402	Requires that Federal agencies insure that any action authorized, funded, or carried by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.	Yes/No	At a minimum, the bald eagle and peregrine falcon, both Federal Endangered species, are known to occur on or in the vicinity of TEAD-N. The affect remedial activities will have on wildlife habitat should be closely evaluated.
Marine Protection, Research, and Sanctuaries Act	13 USC Sec. 1401-1445	Regulates ocean dumping	No/No	TEAD-N is not located near an ocean.
Coastal Zone Management Act	16 USC Sec. 1451-1464	Prohibits Federal agencies from undertaking any activity in or affecting a state's coastal zone that is not consistent to the maximum extent practicable with a state's approved coastal zone management program.	No/No	Not applicable to site conditions at TEAD-N.
Coastal Barrier Resources Act	16 USC Sec. 3501 et seq		No/No	TEAD-N is not in a coastal zone.

TABLE 16-3

IDENTIFICATION OF LOCATION-SPECIFIC PROTECTION STANDARDS (CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
Wild and Scenic Rivers Act	16 USC Sec. 1271-1287 40 CFR Sec. 6.302(E) 36 CFR Part 297	Establishes requirements applicable to water resource development projects affecting wild, scenic, or recreational rivers within or studied for inclusion in the National Wild and Scenic Rivers System.	No/No	No wild, scenic, or recreational rivers are present at TEAD-N.
Rivers and Harbors Act of 1899	33 USC Sec. 403			
Sec. 10 Permit	33 CFR Parts 320-330	Requires permit for structures or work in or affecting navigable waters.	No/No	No navigable waters near TEAD-N.
Policy on Floodplains and Wetlands Assessments for CERCLA Actions	EPA Guidance Aug. 6, 1985	Discusses situations that require preparation of a floodplains or wetlands assessment and the factors which should be considered in preparing an assessment for response actions taken under CERCLA.	Yes/--	National Wetlands Inventory (NWI) maps show the presence of wetlands at TEAD-N. However, it is not clear whether these meet the jurisdictional definitions of wetlands as required by statutes and regulations.
Executive Order on Protection of Wetlands	Exec. Order #11,990 40 CFR Sec. 6.302(A) and Appendix A	Requires Federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists.	Yes/--	May be applicable if wetlands are determined to exist at TEAD-N (see the above comment).
Executive Order on Floodplain Management	Exec. Order #11,988 40 CFR Sec. 6.302(B) and Appendix A	Requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the maximum extent possible, the adverse impacts associated with direct and indirect development of a floodplain.	No/No	There are no documented floodplains on TEAD-N.
Dredge or Fill Requirements	40 CFR Sec. 230-231	Requires permit for discharge of dredged or fill material into navigable waters.	No/No	Remedial activities at TEAD-N will not include discharge of dredged or fill material into navigable waters.

TABLE 16-3

IDENTIFICATION OF LOCATION-SPECIFIC PROTECTION STANDARDS
(CONTINUED)

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comment
__STATE__				
Utah Wildlife Act	Utah Code 23	Establishes provisions covering the taking, possession, and use of wildlife and migratory birds.	No/No	Any remedial technology developed would not involve taking possession of or use of wildlife.
Division of Wildlife Resources Department of Natural Resources	Title 23, Chapter 13, UCA.	General definitions—definitions for Wildlife Resources Code.	Yes/--	May be relevant if remedial actions affect wildlife habitat.
Division of Wildlife Resources Department of Natural Resources	Title 23, Chapter 15, UCA.	Diversion of water—diversion endangering protected aquatic wildlife prohibited.	No/No	Water diversion will not be a part of remedial actions at TEAD-N.
Division of Wildlife Resources Department of Natural Resources	Title 23, Chapter 15, UCA.	Water pollution—pollution of waters containing protected aquatic wildlife (including specified invertebrates) unlawful.	No/No	Remedial actions at TEAD-N will not cause water pollution.

-- Because the Protection Standard is applicable it cannot be relevant and appropriate (designated as --).

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
NWI National Wetlands Inventory
TSD Hazardous Waste Treatment, Storage, and Disposal Facility
MCL Maximum Contaminant Levels

17.0 SUMMARY AND RECOMMENDATIONS

17.0.0.1. This section summarizes the results of the contamination and risk assessments for each of the Group A Suspected Releases SWMUs included in this Phase II RFI. The contamination assessments and risk assessments are summarized from the SWMU-specific RFI results included in Sections 5.0 through 15.0. A recommendation is given for each SWMU regarding how it should be further addressed in the RCRA process, based on risks to human and environmental health.

17.1 CONTAMINATION AND RISK ASSESSMENT SUMMARIES

17.1.0.1. Tables 17-1, 17-2, and 17-3 summarize the contamination assessments and risk assessments for current and future exposure scenarios, respectively. The contamination assessment summary includes the types of chemicals that were selected as chemicals of potential concern for risk assessment evaluations. Also included in Table 17-1 is a brief description of the extent of environmental contamination of these chemicals.

17.1.0.2. Table 17-2 summarizes the risk assessment calculations for the Depot worker according to the current land use. The Depot worker receptor was selected as the most sensitive of the current receptors, and is expected to be the basis for risk management decisions under Corrective Measures Studies (CMS). Also included in Table 17-2 is a summary of the potential for ecological and explosive risks. The ecological assessment is partly quantitative and partly qualitative. The central tendency exposure (CTE) evaluations have been used as part of the interpretation of the human health risks, and consequently are part of the basis for the recommendations as well. Table 17-3 contains a summary of potential future risk scenarios. Because the risks presented in Table 17-3 are based on future exposure scenarios, these data are included for comparison but are not necessarily expected to be the basis of the eventual risk management decisions. However, under Utah Administrative Code R315-101, no further action must be based on a risk evaluation of a residential scenario.

17.2 RECOMMENDATIONS

17.2.0.1. Table 17-4 summarizes the recommendations for each of the Group A Suspected Releases SWMUs. These recommendations are offered according to the current land-use exposure scenarios and the evaluation criteria discussed in Section 3.2.9.

TABLE 17-1

CONTAMINATION ASSESSMENT SUMMARY

SWMU Number	Types of Contaminants[a]	Extent of Contamination[b]
1[c]	Metals Explosives	Broad areas of surface and shallow subsurface soil contamination; highest concentrations in numerous burial pits.
1b	Metals Explosives Dioxins/Furans	Isolated areas of contamination in shallow soils in six burn/burial trenches.
1c	Metals Explosives Dioxins	Isolated areas of contamination in surface and shallow subsurface soils in 15 burn/burial pits.
1d[c]	Metals Explosives	Contamination limited to surface soils around burn pans.
20	Metals Dioxins/Furans	Contamination in surface and shallow subsurface soils (up to 3 feet deep) beneath and immediately adjacent to facility.
21[c]	Metals Explosives Dioxins/Furans	Surface and possibly shallow subsurface soil contamination beneath and immediately adjacent to facility; areal extent not evaluated.
34	Metals Pesticides	Contamination found in surface and shallow subsurface soils around building; subsurface soils to 15 feet beneath wastewater catch tank.
37	Metals Explosives Dioxins/Furans SVOCs	Contamination in surface and shallow subsurface soils around building; surface soils also have low levels of dioxins up to 500 feet from building.
42	Metals Explosives Dioxins/Furans	Surface soil contamination is extensive up to 1,500 feet north and northeast of facility; several ash piles present are potentially hazardous waste; shallow subsurface soil contamination limited to wastewater ditch and Holding Pond areas.
45	Metals SVOCs	Metals in soil and sediment beneath pond; metals and SVOCs in surface water in pond; metals in isolated soils beneath pipelines; no contamination in groundwater.
48	Pesticides SVOCs	Low concentrations found in subsurface soils at one location; concentrations not thought to cause any significant risk.

(a) Types of chemicals that were selected as chemicals of potential concern for inclusion in the risk assessments.

(b) Surface soils are 0.0 to 0.5 feet and shallow subsurface soils are 0.5 to 10.0 feet, unless noted otherwise.

(c) SWMUs included in other RCRA TSD permits that require site assessment and restoration upon closure. RCRA corrective action investigations are thus limited in scope.

TABLE 17-2

RISK ASSESSMENT SUMMARY - CURRENT DEPOT WORKER SCENARIO[(a)]

SWMU Number	Cancer Risk $>1 \times 10^{-4}$	Cancer Risk Between 1×10^{-4} and 1×10^{-6}	Cancer Risk $\leq 1 \times 10^{-6}$	Hazard Index >1	Blood Lead >15 μg/dl	Ecological Risk	Explosive Risk	Comments
1		●		●		●	●	(b)
1b			●				●	
1c			●				●	
1d			●				●	
20			●					
21		●		●	●			(d)
34		●						(e)
37		●						(e)
42		●		●	●	●	●	(b), (c), (d), (e)
45			●					
48			●					

(a) Depot worker was selected as the most sensitive receptor under the current land-use scenario.

(b) The potential for ecological risk requires further study.

(c) Due to likely overestimates of exposure and/or toxicological parameters, the actual cancer risk is probably less than 1×10^{-6}.

(d) Due to likely overestimates of exposure and/or toxicological parameters, a more accurate estimate of the hazard index would probably be less than 1.

(e) CTE cancer risk $<1 \times 10^{-6}$ and CTE hazard index <1

TABLE 17-3

RISK ASSESSMENT SUMMARY - FUTURE SCENARIOS

	Cancer Risk $>1 \times 10^{-4}$	Cancer Risk Between 1×10^{-4} and 1×10^{-6}	Cancer Risk $\leq 1 \times 10^{-6}$	Hazard Index >1	Blood Lead >10 µg/dl	Explosive Risk	Comments
1							
Construction Worker			●	●		●	(b)
Resident	●			●	●	●	
1b							
Construction Worker			●				
Resident	●			●		●	(a)
1c							
Construction Worker			●	●			(b)
Resident	●			●		●	
1d							
Construction Worker			●			●	
Resident	●			●		●	
20							
Construction Worker			●				
Resident		●		●	●		
21							
Construction Worker		●		●	●		(a)
Resident	●			●	●		
34							
Construction Worker		●	●				(a), (b), (c), (d)
Resident	●			●			(b)

(a) Due to likely overestimates of exposure and/or toxicological parameters, the actual cancer risk is probably less than 1×10^{-6}.
(b) Due to likely overestimates of exposure and/or toxicological parameters, a more accurate estimate of the hazard index would probably be less than 1.
(c) CTE cancer risk $\leq 1 \times 10^{-6}$
(d) CTE hazard index <1
(e) Assumes a worker exposure duration of 25 years instead of the current 3 years.

TABLE 17-3

RISK ASSESSMENT SUMMARY - FUTURE SCENARIOS
(CONTINUED)

	Cancer Risk $>1 \times 10^{-4}$	Cancer Risk Between 1×10^{-4} and 1×10^{-6}	Cancer Risk $\leq 1 \times 10^{-6}$	Hazard Index >1	Blood Lead >10 µg/dl	Explosive Risk	Comments
37							
Construction Worker			●				
Resident	●			●			
42							
Depot Worker(e)		●		●	●	●	(b), (d)
Construction Worker		●		●	●	●	(a), (c)
Resident	●			●	●	●	
45							
Construction Worker		●					
Resident	●			●	●		
48							
Construction Worker			●				
Resident	●			●			

(a) Due to likely overestimates of exposure and/or toxicological parameters, the actual cancer risk is probably less than 1×10^{-6}.
(b) Due to likely overestimates of exposure and/or toxicological parameters, a more accurate estimate of the hazard index would probably be less than 1.
(c) CTE cancer risk $\leq 1 \times 10^{-6}$
(d) CTE hazard index <1.
(e) Assumes a worker exposure duration of 25 years instead of the current 3 years.

TABLE 17-4

RECOMMENDATIONS SUMMARY[a]

SWMU Name	SWMU Number	NFA	NFA (RCRA-CA)	RCRA CMS	IRA and CMS
Open Burning/Open Detonation Areas					
Main Demolition Area	1		•(b)		
Burn Pad	1b			•	
Trash Burn Pits	1c			•	
Propellant Burn Pans	1d		•		
AED Deactivation Furnace Site	20			•	
Deactivation Furnace Building	21			•	
Pesticide Handling and Storage Area	34			•	
Contaminated Waste Processing Plant	37			•	
Bomb Washout Building	42			•(c)	
Stormwater Discharge Area	45			•	
Old Dispensary Discharge–Building 400	48			•	

(a) Recommendations based on risks to human or environmental health under current land usage (see Section 3.2.9.).

(b) SWMU 1 is included in this category for additional ecological evaluation. Because it is regulated under another RCRA permit, no CMS will be required.

(c) TEAD has completed an interim remedial action to install fencing around this area and reduce risks.

NFA — No further action is recommended at this SWMU. Levels of contaminants detected do not pose a significant risk to human or environmental health.

NFA (RCRA-CA) — No further action under RCRA corrective action. Levels of contaminants detected do not pose an imminent risk to on-site workers or the environment. Since SWMU is regulated under a RCRA TSD Permit, additional environmental assessment and restoration will be required upon facility closure.

CMS — RCRA Corrective Measures Study recommended. Levels of contaminants do not pose an imminent risk, but may pose significant risks to on-site workers or the environment. CMS is needed to evaluate remedial alternatives.

IRA — Interim Remedial Action recommended. Levels of contaminants may pose an imminent risk to on-site workers or the environment. Interim remedial action followed by CMS is warranted.

17.2.0.2. Based on the results of the evaluations, there are four potential recommendations. These include:

- No Further Action (NFA)–Concentrations of contaminants detected do not pose a significant risk to human or environmental health (i.e., estimated cancer risk less than or equal to 1 x 10^{-6}, hazard index less than or equal to 1.0, and estimated blood lead level less than 10 µg/dl in a residential scenario).

- No Further Action Under RCRA Corrective Action (NFA[RCRA-CA])–Concentrations of contaminants detected do not pose an imminent risk to on-site workers or the environment (i.e., estimated cancer risk less than or equal to 1 x 10^{-6}, hazard index less than or equal to 1.0, and estimated blood lead level less than 15 µg/dl). Since the SWMU is regulated under a RCRA TSD permit, additional environmental assessments and restoration activities will be required upon facility closure.

- RCRA Corrective Measures Study (RCRA CMS)–Levels of contaminants may pose significant risks to on-site workers or the environment (i.e., estimated cancer risk between 1 x 10^{-4} and 1 x 10^{-6}, hazard index greater than 1, or estimated blood lead level between 10 and 15 µg/dl). A Corrective Measures Study is needed to evaluate and select remedial alternatives.

- Interim Remedial Action (IRA and CMS)–Levels of contaminants may pose an imminent risk to on-site workers or the environment (i.e., cancer risk is greater than 1 x 10^{-4}, hazard index is greater than 1, or estimated blood lead level is greater than 15 µg/dl). Interim remedial action followed by a CMS is warranted.

17.2.0.3. As shown in Table 17-4, none of the Group A Suspected Releases SWMUs are believed to pose an imminent risk where interim remedial action is warranted. TEAD has completed an IRA at SWMU 42 that involved installing a fence to reduce the exposure risk. As indicated, most of the SWMUs included in this RFI (SWMUs 1b, 1c, 20, 21, 34, 37, 42, 45, and 48) are recommended for a Corrective Measures Study to evaluate remedial alternatives. At these SWMUs, detected contaminants do not pose an imminent risk, but may pose risks that are considered unacceptable. Potential response actions range from no action to institutional controls or site cleanups, depending on the CMS results. While SWMU 21 has a TSD permit, new pollution control equipment installed after the facility was operating for several years made it likely that the soil contamination

is from past, rather than current activities. Therefore, a CMS is appropriate at this SWMU.

17.2.0.4. At SWMUs 1 and 1d no imminent risks are present; however, they will be the subject of future site characterization and remediation because of other existing RCRA treatment, storage, or disposal permits. To avoid duplication of these efforts, no further action under the RCRA Corrective Action Permit is recommended for these SWMUs. The only exception to this is the Main Demolition Area (SWMU 1), where additional study of the potential ecological risks is recommended.

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